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A Method for the Continuous Measurement of the High Temperature Heat Content of Glasses and of Fused Salts

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I. INTRODUCTION

In recent years the glass industry has become more and more interested in improving the efficiency and economy of glass melting. One of the factors which enters any calculation on furnace efficiency is the heat content of the glass. To date, measurements of the specific heats of glasses as a function of their composition are relatively scarce because they involve complicated equipment and are very time consuming.

A new type of calorimeter developed by W. Oelsen and associates[1] has proven extremely satisfactory for the continuous measurement of the heat content of metals in the range of temperature from 25° to 1000°C. This calorimeter is notable for its simple construction and rapidity of measurement. A heat content-temperature curve between 25° and 1000°C. for a sample can be obtained within one hour. The principle of the method consists of a continuous measurement of the temperature of a sample and of the temperature of a water calorimeter after the sample is transferred from a furnace into the calorimeter. The use of a large sample, i. e., 80 to 300 grams, decreased the cooling rate so that the continuous recording of two temperatures, i. e., that of the sample and of the calorimeter, can be made without technical difficulties.

The present paper deals with a modification of the Oelsen calorimeter for use in the measurement of the high-temperature heat content of glasses and fused salts. The chief objection to the use of an unmodified Oelsen calorimeter for the measurement on glasses and fused salts is the difficulty in obtaining uniform temperature distribution in these materials during an experiment because of their low heat conductivities. In order to circumvent this difficulty without sacrificing the simplicity of the original method, a sample container of special construction was made and the heat content of some glasses and fused salts measured with this modified calorimeter was compared with the published data obtained by other methods.

The methods hitherto used for the measurement of the heat content of glasses and fused salts at elevated temperatures have been reviewed by K. K. Kelley[2] and D. E. Sharp and L. B. Ginther[3]. These methods have certain advantages; for example, the method of mixture has high accuracy. However, the complexity of construction of the calorimeter and the excessive time required for the completion of a test-run seems to have precluded their wide use, resulting in a limited amount of data on heat content, especially for glasses.

II. DESCRIPTION OF INSTRUMENT

(a) Calorimeter

Figure 1 shows the apparatus used for the present investigation. With the exception of the sample container, the construction of the calorimeter is principally the same as that of the Oelsen calorimeter[1]. Dewar flask A (10 liters capacity), is covered by a wood plate, B, which is lined with cork sheets (7mm thickness) on both top and bottom surfaces.

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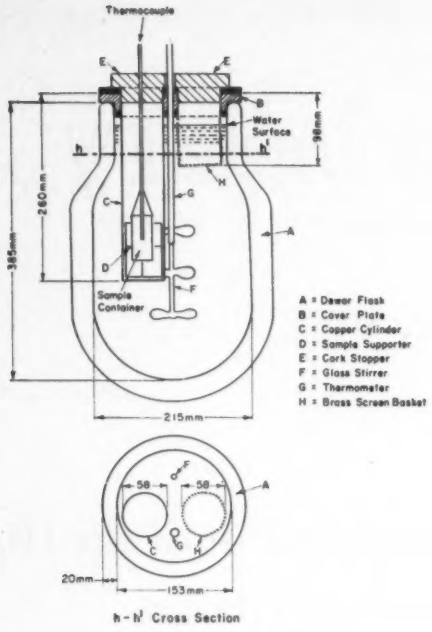

Fig. 1. Calorimeter

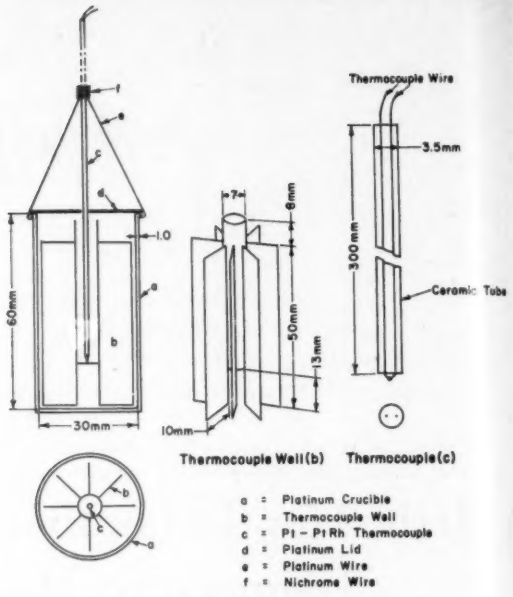

Fig. 2. Sample Container

Inserted through a hole in the wooden cover is a copper cylinder, C (diameter: 58 mm, length: 260 mm), closed at the bottom and containing a nichrome wire sample-supporter, D (6.2 grams) which is surrounded on the outside by aluminum foil (1.5 grams). This aluminum foil serves as a radiation shield, retarding the cooling rate of the sample at high temperatures. Inserted through three other holes in the wooden cover are a cylindrical brass-screen basket, H (diameter: 58 mm, length: 98mm), a glass stirrer, F, connected to a constant speed motor (350 r. p. m.), and a precision thermometer, G (temperature range 19° to 35°C. with 1/50°C. subdivisions).

The copper cylinder, C, and cylindrical wire basket, H, are closed during experimental measurements with cork stoppers, E, covered with aluminum foil. Sudden changes in room temperature should be avoided during a test measurement. However, a special constant-temperature room is not required.

(b) Sample Container

The sample container, shown in detail in Figure 2, consists of a platinum crucible, "a" (weight: 128 grams, wall thickness: 1 mm, interior diameter: 30 mm, height: 60mm) and a thermocouple-well "b" (weight: 55 grams) which consists of a platinum tube closed at the bottom (diameter: 7 mm, length: 45 mm) with eight platinum fins (10 x 50 x 0.45 mm) fitted radially to the tube. The sample level is below the top of the tube. Into this tube is inserted a platinum-platinum rhodium thermocouple, "c" (B & S wire gauge: 24) which is insulated by a two-holed ceramic tube (outer diameter: 3.5 mm, length: 300 mm).

III. PROCEDURE

About 70 grams of the material to be tested is melted in the platinum crucible (Fig. 2, "a") in an electric furnace until bubble formation ceases. After the thermocouple-well "b" is inserted in the melt, the crucible is removed from the furnace and the unit is allowed to cool to room temperature. A platinum lid "d" is placed on the crucible and the thermocouple "c" inserted through a hole in the lid until it touches the bottom of the thermocouple-well "b". The platinum crucible is hung from the insulating ceramic tube of the thermocouple by means of a platinum wire ring with 3-point suspension "e" which is firmly attached to the ceramic tube by thin nichrome wire "f" as shown in Figure 2. This whole unit is then returned to the electric furnace and heated to about 100°C. higher than the temperature from which the measurement of the heat content is to be started. During this period the calorimeter is brought to equilibrium by running the stirrer. After the unit has reached the desired temperature it is transferred into the copper cylinder of the calorimeter (Fig. 1, C) and rested in the nichrome wire supporter, D. A period of approximately 30 seconds is required for the transfer of the crucible and the recording of the first temperature data. The temperature of the sample and the temperature of the water of the calorimeter are measured simultaneously every 15 seconds until the temperature of the sample cools to around 400°C., then every one to three minutes. After the temperature of the sample drops below 100°C., the crucible is transferred from the copper cylinder, C, to the brass-screen basket, H, and immersed in the water up to, but not over, the rim of the crucible. This maneuver allows the temperatures of the sample and the water of the calorimeter to reach equilibrium within a reasonable time (five minutes) as compared with one or more hours if the crucible remains in the copper cylinder.

Knowing the heat content of the calorimeter W, the heat content of the sample H_t^{25} is given by the equation:

$$H_t^{25} = \frac{W\ (\theta_{25}-\theta_t-\triangle\theta'-\triangle-\theta'')}{m}$$

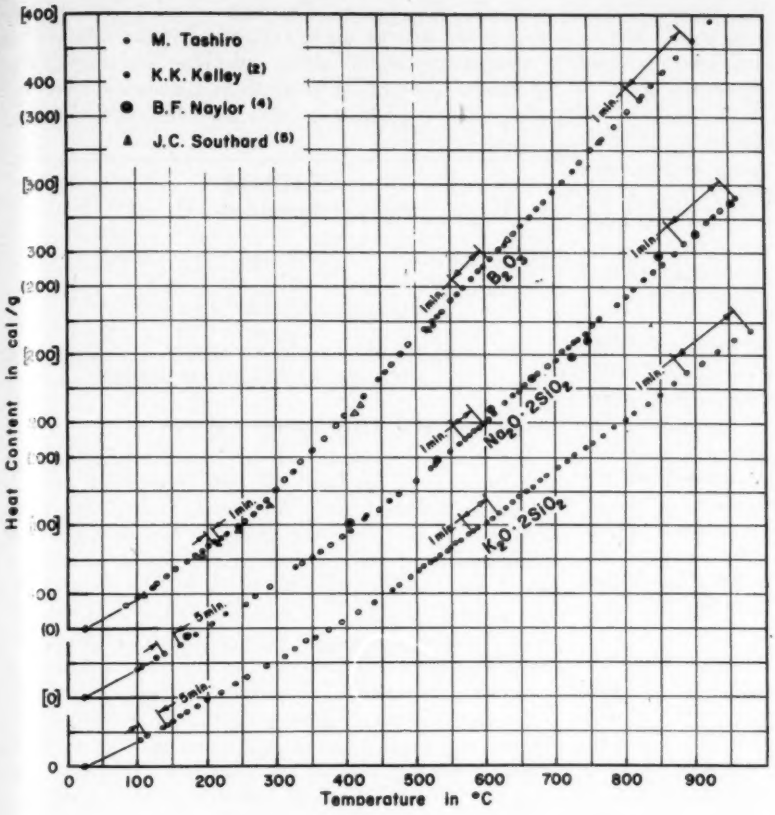

Fig. 3. Heat Content of Glasses

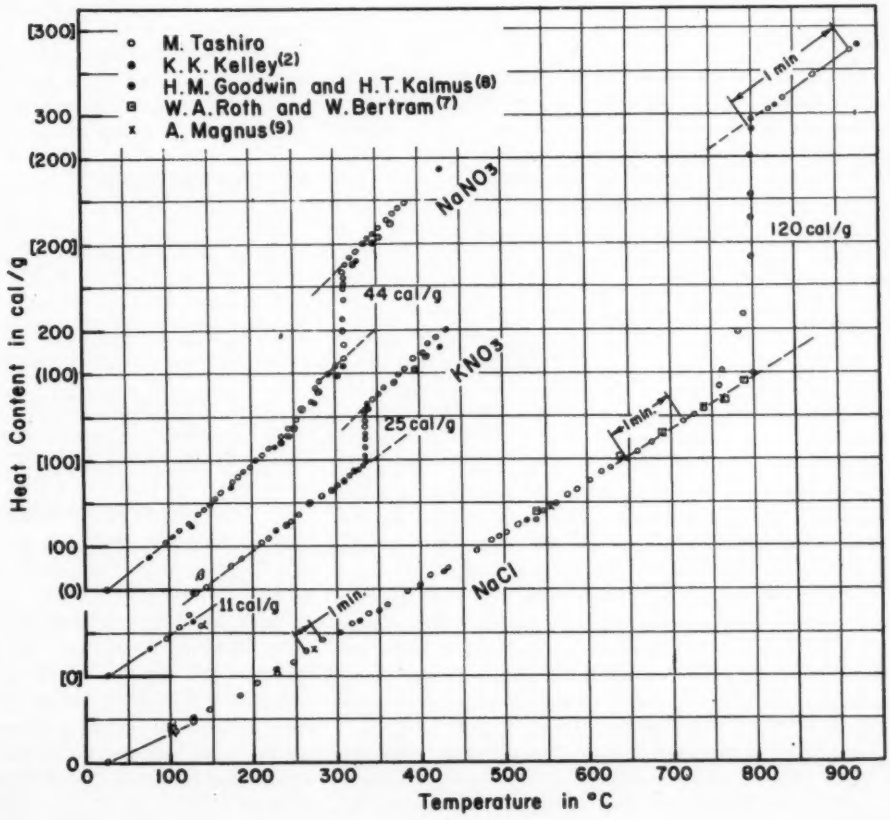

Fig. 4. Heat Content of Inorganic Salts

Where: H_t^{25} = heat content of the sample at any given temperature measured during the course of the experiment referred to the standard temperature 25°C.

W = heat capacity of calorimeter

m = weight of the sample

θ_{25} = calorimeter temperature at time when sample temperature is 25°C.

θ_t = calorimeter temperature at time when sample temperature is t°C.

$\triangle\theta'$ and $\triangle\theta''$ = correction terms expressed as changes in the calorimeter temperature

$\triangle\theta'$ is a correction factor based on the sum of two effects: one, the thermal leakage through the calorimeter wall; the other, the heating effect caused by the stirring of the water. This value can be calculated if the relation between the rate of change in the calorimeter temperature and the temperature difference which exists between the calorimeter and its environment is previously obtained experimentally. $\triangle\theta''$ is the temperature increase caused by the heat which is brought into the calorimeter by the sample container. This value can also be obtained experimentally by a blank test; that is, by a test run with the sample container having no sample.

In the present experiment, the heat capacity of the calorimeter W was determined by using a piece of pure copper as a standard sample whose heat content is accurately known[2]. The weight of the sample was 340 grams and the shape was cylindrical (diameter: 31 mm, length: 49 mm). The thermocouple was inserted into a well drilled in the copper sample extending from the surface to the center of the sample.

IV. RESULTS

The results of the heat content measurements made on boron oxide, sodium disilicate, and potassium disilicate glasses are shown in Figure 3. The glasses were melted in a platinum crucible using chemically pure (C. P.) boric acid, sodium carbonate and potassium carbonate, and potter's flint. As may be seen on Figure 3, the zero ordinates for the three glasses are spaced 40 cal./g. divisions apart for clarity of data presentation. The data for the $K_2O{\cdot}2SiO_2$ glass is plotted on the 0, 100, etc. scale; the $Na_2O{\cdot}2SiO_2$ glass is plotted on the [0], [100], [etc.] scale. The total time for the completion of an experiment, i. e., for the recording of the first point to the recording of the last point shown on the graph for each glass, was about one hour. Three intervals ranging from 1 to 5 minutes are indicated for each glass to show the cooling rate of the sample in relation to data recorded. For each of the glasses measured there is a deflection in the heat content-temperature curve within the transformation range. Above the transformation range, the heat content-temperature curve is a straight line.

For comparison, the published data [2] [4] [5] on the heat contents for the borate and sodium disilicate glasses are also shown on the graph. No published data are available for the potassium disilicate glass. Values given by K. K. Kelley[2] are the compilation of experimental data obtained by many researchers.

The results of the heat content measurements made on sodium chloride, sodium nitrate, and potassium nitrate are shown in Figure 4. The salts were of chemically pure (C. P.) quality. The heat of fusion of the salts was determined by an extrapolation of the heat content —temperature curves above and below the melting temperatures. The values obtained by the author agree well with values obtained from other published data (Table I.)

TABLE I
Heat of Fusion in cal./g.

NaCL	$NaNO_3$	KNO_3
120	44	25
121[6]	45.3[8]	25.5[8]
117[2]	44.7[2]	27.7[2]
126.7[7]		

V. SUMMARY AND CONCLUSIONS

Previous measurements of the heat content of glasses and fused salts required elaborate equipment and an excessive amount of time. A new calorimeter, which was developed by W. Oelsen and associates for the continuous measurement of the high-temperature heat content of metals, was modified for use in the measurement of the heat content of substances which have low heat conductivities such as glasses and fused salts. A new platinum sample-container was designed to promote temperature uniformity throughout the sample during measurement.

The heat content of glasses (boron oxide, sodium disilicate, and potassium disilicate) and of salts (sodium chloride, sodium nitrate, and potassium nitrate) was measured with the modified calorimeter in the temperature range from 25° to 1000°C.) The time required to obtain a heat content-temperature curve for a sample, was about one hour.

This newly developed calorimeter will make it possible to collect accurate data in a short period of time on glasses of many different compositions. This experimental work is being continued in our laboratories.

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Cords In Glass

By M. A. KNIGHT

Part II

TABLE OF CONTENTS

SECTION I. PROPERTIES OF GLASS AND THEIR RELATIONS TO CORDS

IB. Density

IB1. Effect of Composition on Density
IB2. Effect of Heat Treatment on Density
IB3. Measurement of Glass Densities
IB3a. Sink-float methods
IB3b. Centrifuge methods
IB4. Evaluation of Density-Distribution Curves

IC. Optical Properties in Ordinary Light

IC1. General Appearance and Color
IC2. Associated Stones

ID. Thermal Expansion

ID1. Development of Stresses in Cords
ID2. Relation of Thermal Expansion to Composition

IE. Optical Properties in Polarized Light

IE1. Polariscopes
IE2. Polariscopic Appearance of Cords
IE3. Stress Patterns in Cords

IB. Density

IB1. Effect of Composition on Density

For the purpose of quality control, use of the relative densities of glasses is superior to that of other physical properties because of the simplicity and precision with which density can be measured. Since such density control methods are in use in many glass plants, the question of the relation between density and composition becomes important.

A complete review of previously published work on density-composition relationships was published by Sun, Safford, and Silverman (1940). In the same year Huggins (1940a, 1940b) reported his system of calculating density from composition by means of appropriate factors. Huggins' factors were reviewed, and their form somewhat modified, in a note in GLASS INDUSTRY (Anon. 1940). Later, Huggins and Sun (1943) presented complete factors, based on weight percentage, which could be used for calculating absolute densities. This article was also condensed in GLASS INDUSTRY, (Anon. 1943a). The relation of density *changes* to composition *changes* was first discussed by Huggins and Sun (1944) who gave methods for calculating density differences by use of their previously published weight-percentage factors. A resume of this work was published by Sun and Huggins (1946). Stevels (1948) introduced a new method of calculating density from composition, and Huggins and Stevels (1954) compared their two methods critically.

TABLE II

FACTORS FOR CALCULATION OF DENSITY DIFFERENCES IN COMMERCIAL SODA-LIME-SILICA GLASSES*

(Factors are in gm/cc per weight per cent.)

Oxide	(F_M Factors) x 10^4
SiO_2	−24
Al_2O_3	+18
CaO	+106
MgO	+49
CaO·MgO	+82
BaO	+173
Na_2O	+48
K_2O	+28
B_2O_3	−36
ZnO	+145
PbO	+192
Fe_2O_3	+109
TiO_2	+98
ZrO_2	+142

*These are the Y'M-type factors which were developed by Elliot (1945) from the VM factors of Huggins and Sun (1943). They were calculated for N_{SI}=0.40 to 0.435, and hold for typical soda-lime-silica glasses having densities of about 2.44 to 2.55 gm/cc, and silica contents between approximately 69 and 75 weight percent.

TABLE III

FACTORS FOR CALCULATION OF DENSITY DIFFERENCES IN COMMERCIAL BOROSLICILATE GLASSES*

(Factors are in gm/cc per weight per cent.)

Oxide	(F_M Factors) x 10^4
SiO_2	+7
B_2O_3 (B′)	−43
B_2O_3 (B″)	−145
Al_2O_3	+12
CaO	+94
MgO	+42
BaO	+159
Na_2O	+48
K_2O	+35
Fe_2O_3	+96
TiO_2	+82
ZrO_2	+125

*These factors are from the Handbook of Glass Industry (Knight, 1953b). They were calculated for N_{SI}=0.345 to 0.40, and hold for typical borosilicate glasses having densities of about 2.22 to 2.30 gm/cc, B_2O_3 contents between about 11 and 17 per cent, and SiO_2 contents between about 72 and 81 per cent. For the significance of the B′ and B″ forms of B_2O_3 see Huggins and Sun (1943). The weight fractions for B′ and for B″ must be calculated in many instances before the density differences can be found; the need for this must be checked on each glass composition.

The complete bibliography covering all four installments of this paper was published in the September issue.

Dr. Knight was formerly associated with The Preston Laboratories, Butler, Pennsylvania. Now at Minnesota Mining and Manufacturing Company, St. Paul, Minnesota.

The first published set of differential factors developed expressly for the calculation of density differences from composition differences was that of Ghering and Knight (1944). These were computed for typical soda-lime-silica container glasses from the factors of Huggins and Sun. Elliot (1945) modified these differential factors to a more useful form, and tabulated data for both methods. Factors of Elliot's type are given in Tables II and III. These are values which were recalculated and extended for the original of this report, and later published in the HANDBOOK OF GLASS MANUFACTURE (Knight 1953b), where their use is discussed in detail.

These factors are the density changes caused by an increase of one weight per cent in the particular oxide. Thus, they can be used directly to find the net density change when one or more oxides are varied in commercial glasses, as is illustrated in Table IV. They are especially useful for composition changes up to about 2 percent in any given oxide.

Such density-composition factors have proved valuable in checking the accuracy of chemical analyses and in determining the density variations to be expected from batch changes. Conversely, since a given density change might be caused by a wide variety of composition changes, only rough estimates can be obtained of the composition changes corresponding to a particular change in density. As mentioned earlier, however, the coordination of stress and density information helps greatly in these interpretations.

IB2. Effect of Heat Treatment on Density

The effects of previous heat treatment on the densities of typical soda-lime-silica container glasses have been shown in the values published by Ghering and Knight (1944), and by Coe (1949). Measurements made on samples of glass dipped from the melting furnace have been reported by Bishop and Staples (1946), Manring and Waid (1946), and Duff (1947).

These experiments have demonstrated that for use in relative density measurements for control purposes, the well-annealed sample has no particular advantage over the air-quenched, or other, sample, provided only that each treatment is reproducible. The reproducibility of any particular treatment can be determined by measuring typical samples before and after they have been carefully reannealed. The density changes resulting from the reannealing should have the same general reproducibility as is desired in the density measurements themselves.

Probably the most complete study of the effect of annealing on density (and refractive index) is that of Ritland (1954) and Lillie and Ritland (1954). They used careful temperature balancing to measure small density differences between glass pieces. These pieces had been quenched successively from a special furnace which could be either held at constant temperature or cooled at various constant rates. The studies confirm the linear relation of density and index of refraction. They support the fictive temperature concept of A. Q. Tool but do not unequivocally confirm it. They also demonstrate that index homogeneity in large pieces of glass, as well as the absolute index value itself, can best be controlled by constant cooling cycles, and that these schedules can be calculated in advance.

IB3. Measurement of Glass Densities

Ghering and Knight (1944) briefly reviewed the various techniques for measuring glass densities. Since then the use of relative densities has become very general in the control of glass production. Various sink-float methods (Knight 1945b; Duff 1947 and Coe 1949) are used in that work. In all of these, the lumps of the unknown glass are compared to known "standard" lumps, while immersed in heavy liquid, by means of controlled heating (or cooling). More recently, Plumat (1952) described a method for comparing glass lumps by means of pressure variation up to 30 kg/cm² in a glass-windowed bomb. Only a rather restricted range of density variation can be made with a given liquid composition. Ritland (1954), in his very thorough study of annealing effects upon density, used careful temperature balancing to compare the lumps. Another technique for measuring relative densities uses tubes having a stable density gradient (Boyer, Spencer and Wiley 1946; Tung and Tayler 1955). These relative methods are useful for glasses with densities up to about 3 gm/cc. Liquids with very high densities (up to 7.5) are available (Cargille 1951), but unfortunately those in the 3.5 to 7.5 range are opaque. Mine (1949-1953) used complex salt solutions as the heavy liquids in his studies of density measurements as measures of heat treatments. He considers these to have several advantages over the mixtures of organic liquids. He reports that the reproducibility of the settling method decreases appreciably with faster heating rates.

It is much more tedious to measure absolute densities than relative ones. Usually the weighing technique utilizing Archimedes buoyancy principle is used (Sharp and Badger 1953b). This requires a much larger amount of the glass and demands much more care and experience, than do the relative methods. It is used, nevertheless, in calibrating the absolute densities of the "standard" lumps used in the relative methods.

If very accurate density determinations are needed, extreme precautions must be taken. Thus, Seddon (1937a) measured glass densities accurately by a combined flota-

TABLE IV

CALCULATION OF DENSITY DIFFERENCES FROM COMPOSITION DIFFERENCES

Oxides Involved	Wt. Per Cent Changes	Soda-Lime-Silica Glass Density Effects	Soda-Lime-Silica Glass Net Change	Borosilicate Glass Density Effects	Borosilicate Glass Net Change
SiO_2	+1	−0.0024	−0.0024	+0.0007	+0.0007
SiO_2	−1	+0.0024	+0.0042	−0.0007	+0.0005
Al_2O_3	+1	+0.0018		+0.0012	

tion and pycnometer technique using carefully designed all-glass flotation apparatus. Hutchinson and Johnston (1940) measured crystal densities accurately by means of a refined flotation technique. A modified flotation technique was used also by Douglas and Jones (1947) to measure very closely the small density changes caused by various heat treatments. They measured very accurately glasses of high densities by using temperature variations of water, each glass sample being balanced by a very carefully adjusted glass and air float. Ruby and Loveland (1946) described the measurement of powdered materials by a precision pycnometer method. Accurate work with the Archimedes or pycnometer methods likewise requires refinements concerning the buoyancy corrections; see Knight (1945a) and Collett (1954). All of these techniques, however, are too involved and exacting for any process control applications.

IB3a. Sink float methods

The glass samples used in the density comparator described by Knight (1945b) may be lumps taken from lehr-annealed ware or air-quenched samples dipped from the furnace, but they must be of reproducible heat treatment. The samples are identified by numbers scratched on them or by their sizes or shapes. For routine control work it is recommended either that one sample be taken at the same time each day or that five samples be taken at 2-hour intervals during one shift each day. For trouble shooting, moreover, samples may be taken whenever and wherever appears most useful.

The sample lumps are placed in glass tubes each of which contains a heavy liquid of somewhat greater density than that of any of the samples. Each tube also contains a "standard" lump, that is, one whose density is accurately known. Six such tubes are in a water bath which can be heated at a uniform rate. As the heavy liquids are heated, their densities decrease faster than those of the lumps, and the lumps start to settle as the appropriate temperatures are reached. The temperatures at which each lump settles past a reference line which encircles its tube is recorded, and the difference between this temperature and that at which the "standard" lump settles past the line is determined. Either these direct temperature differences or the absolute densities calculated from these differences can be plotted on the statistical control charts.

The precision of this settling method was tested on two sets of samples circulated among eight glass-plant laboratories. Standard deviations within the individual laboratories ranged from 0.00004 gm/cc to 0.00019 gm/cc with a mean of 0.00009 gm/cc, and an overall standard deviation of 0.00008 gm/cc was found for all eight combined.

Details of a somewhat different sink-float procedure were described by Duff (1947). He used cooling of the bath rather than heating, and further discussed the sampling and handling procedures. Tests of both methods were conducted in a number of glass-plant laboratories, and it was found that either could be used for production control. However, the over-all standard deviation of five laboratories using Duff's method was 0.00038 gm/cc, which is to be compared with 0.00008 gm/cc for the eight laboratories using Knight's settling method. Other variations and modifications of the sampling and handling techniques have been described by Bishop and Staples (1946), Manring and Waid (1946), and Coe (1949). The first two of these studies dealt with the taking of glass samples directly from the glass melt at various points in the furnace. Coe (1949) discusses extensive use of density control in bottle-glass production, using equipment very similar to Knight's.

IB3b. Centrifuge methods

The application of density determinations to the problem of cords is facilitated by the stroboscopic centrifuge developed by Turnbull (1941). With this device the density inhomogeneity of a powdered sample of cordy glass can be observed directly. Because the method is somewhat complex and time-consuming it is not useful for routine control purposes in the glass plant (except in the fiber glass industry where glass homogeneity is particularly vital), but it is a powerful laboratory tool for the diagnosis of persistent cord difficulties.

The head of the Turnbull centrifuge has transparent windows above and below each of the four sample tubes. These windows, together with a stroboscopic light which is synchronized with the rotation of the head, permit observation of any one of the four tubes while the centrifuge is rotating. The temperature of the head is controlled by water circulating from an accurately regulated bath.

The sample of cordy glass must first be powdered and the powder outgassed at about 330°* under vacuum. The powder is then put into the sample tube, suspended in an appropriate mixture of light and heavy organic liquids of similar volatilities (the liquid mixture having first been outgassed under vacuum at about 100°). The inclusion of a glass lump of known density with each sample permits the conversion of the temperature readings into density values, since the net change with temperature of the density of the mixture of glass and liquid is known. When these density values are plotted against estimates of the cumulative per cent of the powder which has settled in the tube at each temperature, a cumulative density-distribution curve results.** The determination of one of these curves requires a day or a day and a half, depending upon the sample.

In addition to the determination of density-distribution curves, the centrifuge may be used to separate powdered samples into fractions, or "cuts", of different densities. The sample is first stratified in the centrifuge according to its various densities, and the tube is removed undisturbed. The sample is then separated mechanically into cuts of different density ranges which are chosen on the basis of the previously obtained distribution curve. Such a separation may require about five days. If further separations are run, using the cuts from the first, another two or three days may be needed. The final density fractions are used as samples for chemical, spectrochemical, or other types of analysis. The usual silicate analysis methods were modified by Ghering for use with such small samples. (Turnbull and Ghering, 1941.)

On the basis of the above work, Holland, Preston and Turner (1942) constructed a modified temperature-con-

*All temperatures are given in degrees centigrade unless otherwise indicated.

**All powder which has settled below the 20-mm level in the tube is included in the estimates of the "amount settled" at each temperature.

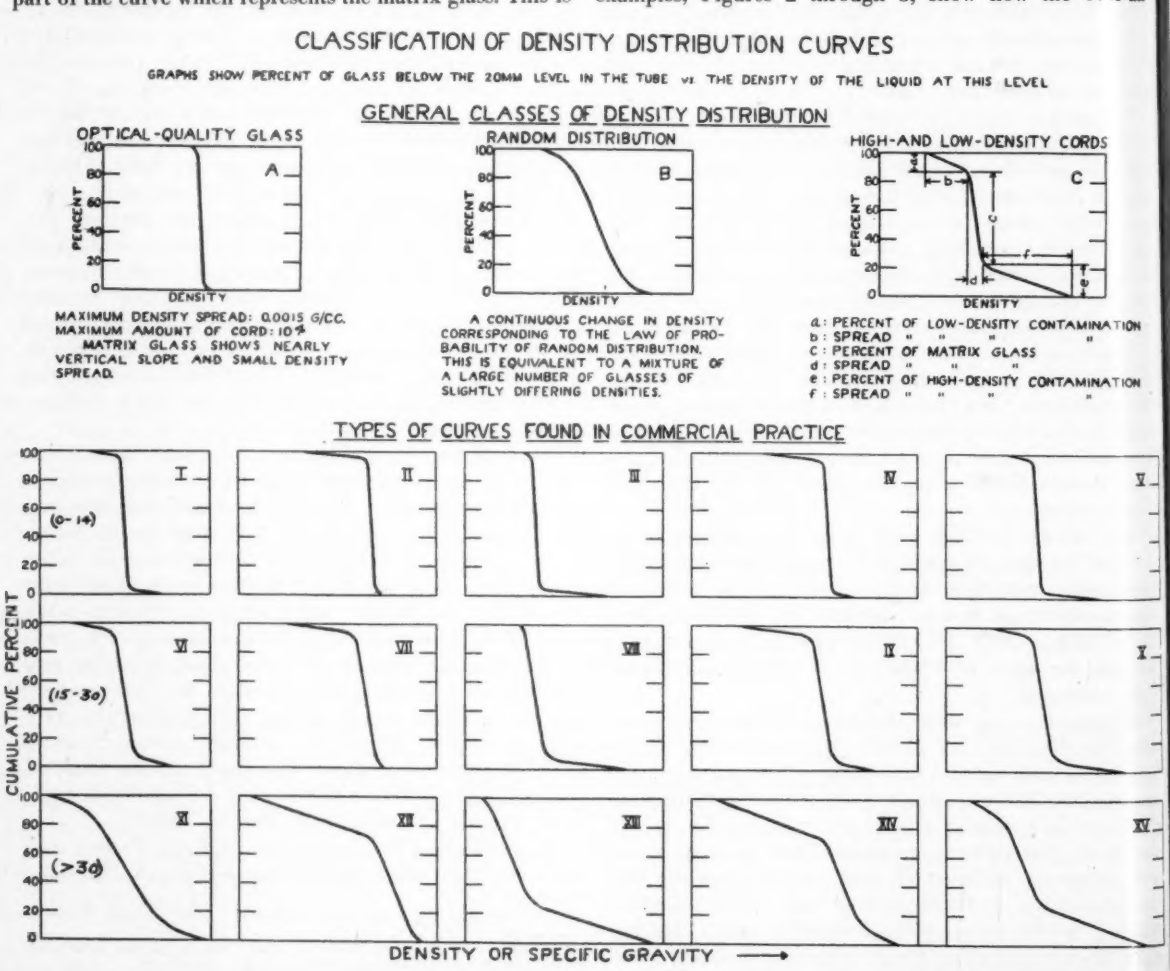
trolled centrifuge which has twelve sample tubes but not stroboscopic illumination. Tooley and Tiede (1944, 1945, 1946) also modified Turnbull's ideas, using cooling rather than heating. They determined the density distributions of glasses melted for various lengths of time in stationary and in rotating platinum crucibles. Their object was to evaluate diffusion factors in homogenization as distinguished from mechanical or convection factors. They also studied the effects of batch particle size and of batch mixing time. Plumat (1953b) likewise used cooling, primarily, in a similar instrument to study the density homogeneity of production samples. He also applied this technique to study of powdered brick samples to evaluate the relative amounts of the various mineralogical phases.

IB4. Evaluation of Density-Distribution Curves

Typical density-distribution curves which may be plotted from the data obtained with the Turnbull centrifuge are shown in Fig. 1. Each consists of a low-density portion, a middle portion representing the matrix glass, and a high-density portion, as shown in detail by curve C. For the purpose of comparing curves for different samples, there is assigned to each curve a Point Rating which is based on three parameters: (1) The *amount of cord.* This is the sum of the percentages of light and heavy cord. It is equal to (a + e) of curve C. (2) The *slope* of that part of the curve which represents the matrix glass. This is the density spread included by a straight line drawn through the matrix part of the curve and extending from 0 percent to 100 percent. It is expressed as (———gm/cc x 10^4). (3) The *total density spread of the sample.* This is the difference between the density of the heaviest glass and that of the lightest. It also is expressed as (——gm/cc x 10^4).

After these parameters have been computed, the point value of each is to be obtained from Table V. These point values are based on the relative importance of the three parameters to the quality of the glass. The sum of the three point values is the over-all Point Rating of the curve and hence of the glass. The larger the Point Rating of the sample (maximum of 100), the closer the glass is to optical quality.

Although these density-distribution curves do give a semi-quantitative measure of the heterogeneity of the glass, this heterogeneity can be estimated qualitatively from the simpler and more rapid polariscopic examination and lump-density determinations. The distribution curves prove most useful, therefore, in cord diagnosis, of themselves and also as a basis for the planning of density separations, and as a check on the chemical analysis of the separated fractions. Examples of the application of the centrifuge to typical cord problems encountered in commercial practice are discussed under Section II. Those examples, Figures 2 through 5, show how the over-all



Point Rating of a glass sample is computed. (Since these were cordy samples, the ratings are low.)

In 1942, a general survey of glass homogeneity was made which involved a large number of American glass container plants. The average Point Rating of 103 samples from 95 tanks was 73.1, whereas six months later the average of 88 samples from 81 tanks was 82.2. Although this would seem to indicate some improvement with respect to cordiness, the data were not sufficient to attribute a true significance to the difference. The samples included both good and poor glass, and the range of variation was large. In 1945 a series of tests of 18 flat glasses yielded an average rating 63.7 points. From these surveys, it was not possible to differentiate between various methods of glass manufacture with respect to types and relative amounts of cord, but it was noticed that the cord types found were mainly those associated with refractory contamination.

IC. Optical Properties in Ordinary Light

IC1. General Appearance and Color

Some cords are apparent in the gob or in the hot ware during its fabrication as particularly luminous bands or as dark streaks. For example, cords which contain excess iron have been reported to show remarkable luminosity in the gob, and yet not to be noticeable sometimes in the finished ware.

In the ware, cords can cause four types of irregularities visible in ordinary (nonpolarized) light: (1) variations in wall thickness, (2) index of refraction variations, (3) off-color areas, and (4), in extreme cases, surface cracks. Stones associated with cords obviously are another visual warning of cordiness. One of the dominant visual effects in container ware is the distortion of objects viewed through it. This is due partly to irregulari-

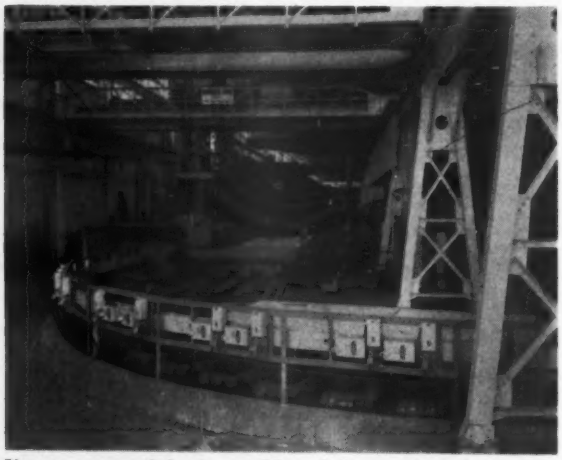
(*Continued on page* 570)

TABLE V

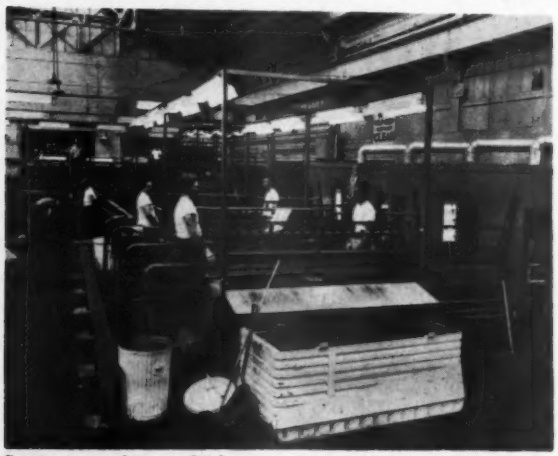
POINT RATING SYSTEM FOR DENSITY-DISTRIBUTION CURVES

(1) AMOUNT OF CORD				(2) SLOPE OF MATRIX				(3) TOTAL DENSITY SPREAD					
%	Pts.	%	Pts.	Slope	Pts.	Slope	Pts.	Unit	Pts.	Unit	Pts.	Unit	Pts.
0.10	20.0			0-5	30.0			0-15	50.0	57	33.2	100	16.0
										58	32.8		
11	19.6	36	9.6	6	29.3	31	12.7	16	49.6	59	32.4	101	15.6
12	19.2	37	9.2	7	28.7	32	12.0	17	49.2	60	32.0	102	15.2
13	18.8	38	8.8	8	28.0	33	11.3	18	48.8			103	14.8
14	18.4	39	8.4	9	27.3	34	10.7	19	48.4	61	31.6	104	14.4
15	18.0	40	8.0	10	26.7	35	10.0	20	48.0	62	31.2	105	14.0
										63	30.8		
16	17.6	41	7.6	11	26.0	36	9.3	21	47.6	64	30.4	106	13.6
17	17.2	42	7.2	12	25.3	37	8.7	22	47.2	65	30.0	107	13.2
18	16.8	43	6.8	13	24.7	38	8.0	23	46.8			108	12.8
19	16.4	44	6.4	14	24.0	39	7.3	24	46.4	66	29.6	109	12.4
20	16.0	45	6.0	15	23.3	40	6.7	25	46.0	67	29.2	110	12.0
										68	28.8		
21	15.6	46	5.6	16	22.7	41	6.0	26	45.6	69	28.4	111	11.6
22	15.2	47	5.2	17	22.0	42	5.3	27	45.2	70	28.0	112	11.2
23	14.8	48	4.8	18	21.3	43	4.7	28	44.8			113	10.8
24	14.4	49	4.4	19	20.7	44	4.0	29	44.4	71	27.6	114	10.4
25	14.0	50	4.0	20	20.0	45	3.3	30	44.0	72	27.2	115	10.0
										73	26.8		
26	13.6	51	3.6	21	19.3	46	2.7	31	43.6	74	26.4	116	9.6
27	13.2	52	3.2	22	18.7	47	2.0	32	43.2	75	26.0	117	9.2
28	12.8	53	2.8	23	18.0	48	1.3	33	42.8			118	8.8
29	12.4	54	2.4	24	17.3	49	0.7	34	42.4	76	25.6	119	8.4
30	12.0	55	2.0	25	16.7	50	0.0	35	42.0	77	25.2	120	8.0
										78	24.8		
31	11.6	56	1.6	26	16.0			36	41.6	79	24.4	121	7.6
32	11.2	57	1.2	27	15.3			37	41.2	80	24.0	122	7.2
33	10.8	58	0.8	28	14.7			38	40.8			123	6.8
34	10.4	59	0.4	29	14.0			39	40.4	81	23.6	124	6.4
35	10.0	60	0.0	30	13.3			40	40.0	82	23.2	125	6.0
										83	22.8		
								41	39.6	84	22.4	126	5.6
								42	39.2	85	22.0	127	5.2
								43	38.8			128	4.8
								44	38.4	86	21.6	129	4.4
								45	38.0	87	21.2	130	4.0
										88	20.8		
								46	37.6	89	20.4	131	3.6
								47	37.2	90	20.0	132	3.2
								48	36.8			133	2.8
								49	36.4	91	19.6	134	2.4
								50	36.0	92	19.2	135	2.0
										93	18.8		
								51	35.6	94	18.4	136	1.6
								52	35.2	95	18.0	137	1.2
								53	34.8			138	0.8
								54	34.4	96	17.6	139	0.4
								55	34.0	97	17.2	140	0.0
										98	16.8		
								56	33.6	99	16.4		

Long grinding and polishing lines recently put into operation at the Ottawa, Illinois plant. These new double lines are similar to new equipment installed at the Toledo plant.



New turnaround for iron tables of the grinding and polishing lines at the Ottawa, Illinois plant. Tables operate together as a continuous unit, then are individually turned around, and routed back under a similar grinding and polishing line. Tables are cleaned in the operation. Electronic controls govern the turnaround mechanism. Similar equipment has been installed in the expansion of the Toledo plant.



Cutting machine which cuts large plates of glass into working sizes in Toledo plant. Operators closely inspect each piece of plate glass after cutting.

L-O-F Achieves on Huge

Libbey-Owens-Ford Class Company, with its plate, window and safety glass plants located in five states, has completed and put into operation new facilities at Toledo, Ohio, and Ottawa, Ill., which increase its capacity for making polished plate glass by conventional methods 50 per cent.

It is believed something of a world-record in glass factory construction was achieved when the East Toledo expansion including two new 1,100-ton glass melting tank furnaces, a new grinding and polishing line, and additional bending and laminating plant and facilities were completed and put into operation in nine months.

Overlapping was the construction of a building and installation of a new double plate glass grinding and polishing line at Ottawa, Ill., which was put into operation the final week in June.

The program also included expansion of the two twin-grinding plate glass units at the Rossford, Ohio, plant of Libbey-Owens-Ford which improvements were scheduled to coincide with routine rebuilding of plate glass melting tank furnaces serving them. The No. 1 twin-grinding plant expansion was completed in record time early this year and the No. 2 twin expansion will probably be completed by the end of the year. Meanwhile, both twins are producing and the No. 2 twin is the largest twin plate glass capacity unit in the world.

The overall L-O-F expansion program cost more than $54,000,000 provided out of company funds without recourse to any new financing or bank loans.

Window glass production by Libbey-Owens-Ford in two plants at Charleston, West Virginia, and Shreveport, Louisiana, has been substantially increased through gradual improvements in the last two years. Additional changes including widening of machines, application of new engineering, and improvement of tank construction will be made under a four-year schedule starting next year.

The two big plants at Toledo and Ottawa are now integrated units. Each has two large plate glass tank furnaces, lehrs, and plate glass blank storage facilities, four grinding and polishing lines, and requisite automatic cutting machines, laminating and bending equipment. Each plant is capable of producing a modern, panoramic windshield starting with the batch, and carrying through every operation to the completed, packed and cartoned windshield.

Each of these plants makes some traditional specialty products such as aircraft glass, bullet-resisting glass, laminated plastic aircraft parts, tank periscopes, vision blocks, electrical-conducting glass, television plates, and other flat glass products.

The big expansion was rushed through in record time to meet the exceptional growth in demand for glass in

Construction Record Factory Expansion

the building construction and automobile fields based partly upon the rapidly-gaining population in the United States and the design trend toward larger uses of glass.

Traditionally it takes two or more years to make an appreciable addition to the capacity of a plate or window glass plant but the Libbey-Owens-Ford record in 1955-56 was made possible to a large extent by teamwork between a well-experienced contractor and the company engineering staff.

The A. Bentley & Sons Company, general contractors, at Toledo, founded in 1875, built the first plant of the Edward Ford Plate Glass Company in Rossford in 1898-9 and also the first units for grinding, polishing and laminating auto safety glass for Libbey-Owens Sheet Glass Company, in East Toledo in 1926 and 1928. These two companies formed the present Libbey-Owens-Ford Glass Company in 1931.

Back in 1938 when the first big L-O-F plate glass melting tank was built at Ottawa, Illinois, it took the Bentley organization a full year to complete the job. A similar tank built at Rossford, Ohio, in 1940, encountered some material difficulties, and it took more than 15 months to complete. Subsequently, second furnaces were built at both of these plants by the Bentley organization.

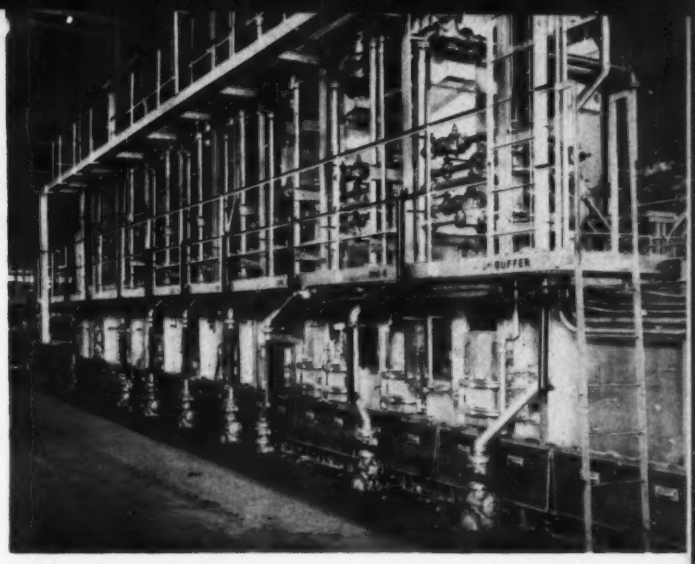
However, the East Toledo job last year was the first time anywhere in the world that two of these big tank furnaces were constructed simultaneously and one put into production in nine months. The A. Bentley & Sons Company was the general contractor on this project.

C. W. Davis, executive vice-president—production, for Libbey-Owens-Ford, gives equal credit to the contractors and his own L-O-F engineering staff, for close teamwork throughout on the exacting technical construction work.

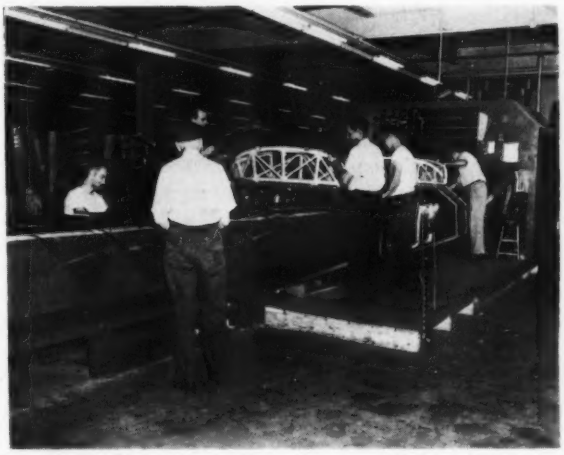
The new construction at the East Toledo plant, which for the first time gave that plant units for the basic manufacture of glass and bending furnaces for making curved glass, plus enlargement of grinding and polishing equipment and laminating facilities, provides probably the largest amount of new plate glass productive capacity added to existing plants anywhere in the world. It is the first such expansion that included two of the big 1,100-ton continuous melting furnace tanks.

The East Toledo job involved the moving of more than 500,000 cubic yards of grinding waste materials and earth to establish a ground level area for the plant. Drainage work, relocation of a county creek, sewers, and foundation for the massive supports of the heavy glass melting tanks were some of the deep underground preliminary operations. The Bentley firm started this grading work on February 28, 1955. The first furnace was put into operation on December 6, 1955.

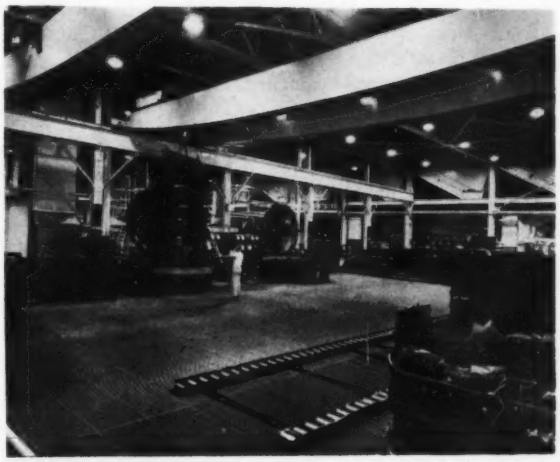
Second of the new furnaces at East Toledo went into production on March 6, 1956, marking the virtual completion of the current project at that plant.



This three-story bending furnace is in the Rossford L-O-F factory.



Final inspection of panoramic windshields in the Toledo plant. Each windshield is gauged on an accurate contour mold to test the final curvatures.



New autoclaves laminate modern panoramic windshields in the Toledo plant.

Each of the two furnaces has a 213-foot stack. The batch silos are eight-in-line and were poured in a continuous operation in the six days from August 29 to September 3. They rise 94 feet above ground level, are each 37 feet in diameter and form a group 293 feet long. They required 4,500 cubic yards of ready mixed concrete. Foundation caissons extend 65 feet into the ground to provide a solid base for the heavy structure. These silos store silica sand, soda ash, salt cake, ground limestone and other ingredients for making plate glass. They receive the materials from hopper cars.

Each of the new tank furnaces holds approximately 1,100 tons of molten glass. Natural gas is used for melting but fuel oil and refinery gas are available as stand-by fuel.

At the casting end of the tanks the glass moves through forming machine rolls where it is "cast" into a moving ribbon of rough plate glass 106 inches wide.

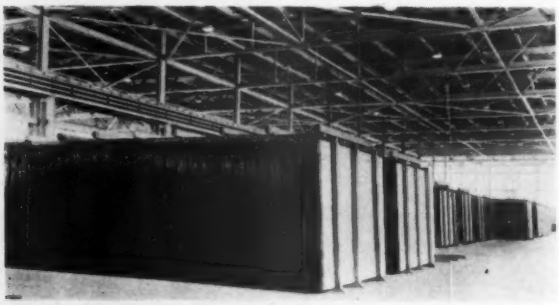
The glass is stored on large bucks in the new storage building, which is 200 feet wide and 576 feet long, with a capacity for holding 20,000,000 sq. ft. of glass. This warehouse has two 100-foot bays, one equipped with large cranes, and the other with a single crane. A railroad spur leads into the building. For easy handling it brings in the cars at floor level. Rail facilities, including some special glass transport cars, form the link between this new glassmaking unit at East Toledo with glassmaking operations at Ottawa, Illinois, and Charleston, West Virginia, and other plants.

Glass moves from the storage warehouse through an enclosed passageway to the rear of the grinding and polishing plant. There the No. 1 line, of latest design, teamed with No. 2 line, handles a steady flow of glass through both the grinding and polishing operations. The cars or tables which convey the glass under the grinding or polishing heads by means of a new turnaround system at either end, electronically controlled, form virtually a continuous table or moving support for the glass. The lines are 1,100 feet long.

Older type lines use a transfer system in which the cars at the end of the run are moved from one line to the other after stripping of glass and cleaning.

Historically it is interesting that the newest No. 1 line now occupies the same general plant area in which the first primitive round table type of machinery was set up in 1926 for the grinding and polishing of automotive glass. That type of operation has long been superseded by continuous methods.

This big construction project, involving heavy foundation work, was carried on by The A. Bentley & Sons Company while the other three lines were operating at peak load last year. The new line was put into operation on December 1, 1955.



Storage of rough plate glass in new warehouse at Toledo plant. Glass here comes off production and is enroute to grinding and polishing lines.

The third large project in the expansion of the East Toledo plant is the addition of nearly 200,000 sq. ft. of space to house new bending and laminating facilities. This plant now has about 13½ acres under roof devoted entirely to manufacture of automotive and kindred laminated glass products.

A separate contract was let for the expansion of the bending and laminating facilities at this plant to expedite this phase of the construction. George W. Lathrop & Sons, Inc., carried out this work to meet the schedules for increased automotive glass facilities.

The new portion of this plant is L-shaped with one section west of present plant 680 feet long and 240 feet wide and the other section north of the present plant, 80 feet wide and 397 feet long.

This structure also involved heavy foundations for new autoclaves and bending furnaces. It is of steel frame, glass and aluminum walls, and precast concrete slab roof. It was built by George W. Lathrop & Sons, Inc. on an April-to-December schedule.

Other important structural features of the big expansion at East Toledo include a 750,000-gallon water tank with cooling towers, a large concrete slab cullet storage area, oil storage tanks of 1,100,000 gallons capacity, nearly two miles of railroad trackage, and approximately a mile of concrete roadway for truck movement in the plant area, extensive additions to the electric substation and power plant including more boiler capacity.

At Ottawa, Illinois, a complete new double line, similar to that at East Toledo, started in July, 1955, was installed in a new building and it began operations on June 26, 1956.

The Ottawa construction and installation of the grinding and polishing lines was also handled by the Bentley organization. It added approximately 250,000 sq. ft. of floor area to the big L-O-F plant at Ottawa. More than 2,000 tons of structural steel was used for the modern building and heavy concrete foundations were installed for the grinding and polishing machinery. Many auxiliary facilities were also included in the expansion. New washing and cutting areas were provided, plus new warehouse and storage areas, refractory storage facilities, additional cullet storage, and expansion of the power house.

The Ottawa double line, similar to the new single lines at East Toledo, handles glass 100 inches wide.

Of interest from the financial side is the revelation that the entire expansion has been paid for by the company without recourse to any new financing or bank borrowing.

Libbey-Owens-Ford set up a plant improvement and replacement fund back in 1937 into which quarterly transfers of depreciation allowances in cash are made plus earnings retained in the business and certain special appropriations. At the end of 1955 this fund was $24,266,634. Through the years it has been in operation it has provided ready funds for hundreds of improvements which have helped to retard advancing costs due to higher wages and rising material prices. Pending actual charge-out the funds are invested in government bonds

(*Continued on page* 584)

Recent Translations of Russian Papers of Interest to the Glass Industry

Efficiency of Russian Sheet Glass Plants

I. Ben in *Steklo i Keramika (Glass and Ceramics)*, vol. *11*, No. 6, p. 25 (1954), brings some interesting statistical data.

It is clear that the productivity of a sheet glass plant, at constant speed of working is higher, the smaller the ratio of the tank area to the total width of the glass sheets withdrawn from the furnace at any moment. If the area is expressed in square meters and the combined sheet width in meters, this ratio varied from 12 to 29 in 1953 in Russian glass factories.

The mean rate of withdrawal varied, in the same year, between 52 and 91 meters/hour for the sheet of standard thickness.

The yield of sound glass per meter of tank area was 21[illegible] kg. in the worst and 427 kg. in the best establishment. The best glass tank reached 530 kg./square meter. The percentage of rejected glass was confined between between 19 per cent and 35 per cent.

The utilization of time was 81.5 per cent to 94.9 per cent; i.e. the least fortunate tank stood idle 19.5 per cent of the year while the best one lost only 5.1 per cent of the time.

The expense of "standard fuel" per metric ton of acceptable glass was as low as 0.865 and as high as 1.57 metric ton.

The costs of tank repair made up 6.3 to 7.3 per cent of the self-costs of the sheet glass.

Chemical Endurance of Zirconia Glasses

Glasses containing zirconium oxide are relatively resistant to water and some reagents. This resistance was measured by O. K. Botvinkin and B. V. Tarasov and reported on in *Steklo i Keramika (Glass and Ceramics)* vol. *11*, No. 6, p. 12 (1954) for high zirconium amounts and by K. T. Bondarev *(Steklo i Keramika (Glass and Ceramics)* vol. *11*, No. 7, p. 19 (1954)) for small zirconia concentrations.

Botvinkin and Tarasov heated glass powder apparently in water vapor at 310°C. Of the 12 glasses tested, the least weight loss was observed for the glasses whose composition was near to

SiO_2 62, Na_2O 17, ZrO_2 21 weight per cent.

Such a glass lost, e.g., 30 mg. per square decimeter of the surface in 4 hours and 40 mg. in 20 hours, while

TABLE I

Chemical Composition, weight per cent

SiO_2	B_2O_3	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	SO_3	ZrO_2	*W*	*A*
					"Pyrex", polished						
79.8	12.0	2.5	0.06	0.25	0.10	4.1	1.0	0.2	——	0.067	16
					Sheet glass, fired polished						
72.1	——	0.83	0.08	7.5	3.2	15.8	——	0.51	——	0.09-0.13	29-37
					Mirror glass, polished						
71.5	——	0.44	0.08	13.3	0.2	8.5	5.5	0.37	——	0.06-0.09	40-55
					Plate glass, polished						
71.5	——	0.32	0.07	12.5	0.2	15.0	——	0.45	——	0.08-0.13	43-52
					"K 3", polished						
71.3	7.8	0.45	0.04	1.4	0.2	7.2	11.2	0.5	——	0.026	42
					Base for zirconia glasses						
75.0	——	0.43	0.05	8.6	0.11	15.0	——	0.5	——	0.10-0.14	38-49
					Zirconia glasses, polished						
74.9	——	0.43	0.05	8.6	0.11	15.0	——	0.5	0.1	——	37-39
74.5	——	0.43	0.05	8.6	0.11	14.9	——	0.5	0.6	0.09	32-36
74.5	——	0.43	0.05	8.5	0.11	14.7	——	0.5	0.8	0.09	28-32
74.4	——	0.43	0.05	8.5	0.11	14.7	——	0.5	0.9	0.09	27-34

quartz glass treated in the same manner lost 45 mg. in 4 hours and 125 mg. in 20 hours.

Chemical endurance of glasses containing less than 1 per cent ZrO is compared with that of some other high-endurance glasses in Table I. In this table column *W* lists the weight loss in water (expressed in mg./square decimeter) and column *A* the weight loss in an alkali solution (same units); the tests were conducted in accord with the Russian standard method GOST 111-41.

The zirconia glasses mentioned in Table I were made in pots. Glasses containing 0.3 - 0.5 per cent ZrO_2 were then prepared in a glass tank. It was found that zirconia had to be introduced as the mineral zircon (ZrO_2, SiO_2) because ZrO_2 required too much time to dissolve in the glass melt.

By using zircon, Botvinkin and Tarasov, see *Steklo i Keramika (Glass and Ceramics)*, vol. *11*, No. 7, p. 18 (1954), succeeded in making a glass containing up to 36 per cent ZrO_2. Glasses containing this high concentration of ZrO_2 require a very high melting temperature, near 1600°C. Glasses containing 21 per cent ZrO_2 can be prepared at 1500°C. The composition

SiO_2 62.5, ZrO_2 21.0, Na_2O 14.0, K_2O 2.5 per cent

was recommended for water gauges in boilers.

A New Laboratory Glass

A new type of glass for chemical laboratory ware was described by N. N. Kachalov, K. S. Evstropev, S. K. Dubrovo, V. M. Lipkin and K. I. Borisov in *Steklo i Keramika (Glass and Ceramics) 11*, No. 7, p. 20 (1954).

Its composition is

SiO_2 68.6, Al_2O_3 3.7, CaO 7.5, BaO 3.5, MgO 3.5, K_2O 3.0, Na_2O 10.0, F 0.2 per cent

as compared with the composition of Glass No. 23 worked out by V. E. Tishchenko over 50 years ago and still widely used in Russian laboratories:

SiO_2 68.38, B_2O_3 2.66, Al_2O_3 3.88, CaO 8.51, K_2O 7.14, Na_2O 9.42 per cent

In a pot the new glass (designated as No. 29) was made from 55 parts of batch and 45 parts of glass fragments. The procedure was as follows: heat the pot to 1370°-1380° C., introduce the fragments, raise the temperature within 1.5-2 hours to 1410°-1420° C., introduce half the batch, maintain at 1420°-1430°C for 2-3 hours, add the rest of the batch, and maintain at 1440°-1450°C. for additional 7-8 hours. This is a less difficult régime than making glass No. 23 in which the required temperature is, on all stages, about 20°C. higher.

In a tank furnace, glass No. 29 is melted and fined 1430 ± 10°C. Laboratory ware is blown from this glass at 1230°-1240°C. The glass does not devitrify when worked in a flame.

In Table I some important properties of glass No. 29 are compared with those of No. 23.

In the actual laboratory use, vessels made of glass No. 29 behaved exactly as those made of the familiar glass No. 23

The lower cost of the raw materials of glass No. 29 as compared with No. 23 is one of the advantages of the new glass. It was feared that the new melt may prove to be more corrosive to the furnace refractories than the melt of No. 23. This, however, was not the case. Also the other indicators such as fuel expense, glass yield per unit area, and so on, were almost identical for No. 29 and No. 23.

Calculation of the Relative Amounts of Ferrous and Ferric Oxides in Glass from Its Light Transmission

Because of the difficulty of a chemical determination of ferrous oxide in glass, I. E. Shapiro, in *Steklo i Keramika (Glass and Ceramics) 9*, No. 12, p. 9 (1952), suggests a determination based on the light transmission of the glass.

The method rests on the assumption that the light absorption is due to iron oxides only. The "specific absorption" by FeO in glass, averaged over the visible region of the spectrum, is 0.079; in other words, a 1 mm. thick pane of glass containing 1 weight per cent of FeO absorbs 7.9 per cent of the visible light falling on it in the normal direction. The analagous coefficient for Fe_2O_3 is 0.007.

If T is the ratio of non-absorbed to total light intensity then $\log T = -\alpha x l$, if α is "specific absorption" as defined above, x is the percentage of the absorbing component, and l, the thickness of the glass sheet. In the presence of two absorbing components, the right hand side of the equation contains two analogous terms. Thus, for FeO and Fe_2O_3,

$$-\log T = [0.007x + 0.0071(c\text{-}x)]\ l,$$

x is the initial weight percentage of Fe_2O_3 and c the weight percentage of total Fe_2O_3 in glass, i.e. after oxidation of any FeO present; c has to be measured by chemical means. The coefficient at $(c\text{-}x)$, i.e. at the initial percentage of FeO, is 0.071 rather than 0.079 because 71 parts of FeO yield 79 parts of Fe_2O_3 on oxidation.

The ratio transmitted to total light intensity (let this ratio be τ is smaller than T because of reflection of light from the two sheet surfaces. For usual glasses, the reflection causes the loss of 8.6 per cent. Thus 8.6 per cent must be added to the measured value of τ to obtain T.

TABLE I

	Glass No. 23	Glass No. 29
Weight loss, mg. per 100 cm^2, on boiling in distilled water	0.30 - 0.84	0.20 - 0.70
N sulfuric acid	0.14 - 0.40	0.00 - 0.26
2 *N* sodium hydroxide	40 - 59	38 - 59
2*N* sodium carbonate	8	6
Volume coefficient of thermal expansion	264 x 10^{-7}	234 x 10^{-7}
Softening temperature, °C.	565 - 575	560 - 580

Inventions and Inventors

Glass Wool and Fiber

Class Paper. Fig. 1. Patent No. 2,728,699. Filed November 23, 1953. Issued December 27, 1955. Two sheets of drawings. Assigned L-O-F Glass Fibers Co., by Dominick Labino.

A primary object of the present invention is to provide a novel glass paper of improved tensile strength.

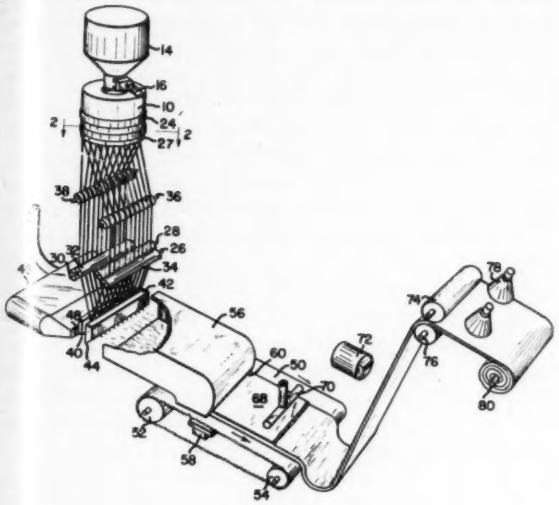


Fig. 1

There is shown in Fig. 1 a glass melting pot 10, of platinum or suitable alloy for the heating and melting of glass marbles which are fed from hopper 14, in response to the actuation of solenoid 16, which is itself governed by the depth of molten glass in the pot. Accordingly, a constant glass level is maintained in pot 10.

Positioned below the glass melting pot 10 are two sets of shafts 26, 28, and 30, 32, driven by suitable means (not shown) and upon which are mounted drawing rolls as indicated generally at 34. In the operation of the apparatus the primary filaments pass between and are drawn by the drawing rolls. In the practice of this invention the shafts 26, 28 are driven at one speed and the shafts 30, 32 at a higher speed. High drawing rates normally produce smaller filaments and, consequently, the combination of variation in drawing rate with changes in aperture size permit a high degree of controlled variation in the primary filament.

The primary fibers pass from the drawing rolls and are advanced over the flat face 40 of a guide block 42, having a V-shaped forward edge 44; the fibers as they approach edge 44, it will be noted, are in a substantially vertical planar arrangement.

In horizontal alignment with edge 44 is a gas burner 46, having a discharge slot 48, through which a high temperature high velocity gas blast may be discharged at the ends of the glass fibers as they pass edge 44. The heat of this blast causes the ends of the fibers to be melted and the force of the gases causes the molten glass of each of the fibers to attenuate into very fine diameter fibers—that is, fibers having a diameter of one micron or less. Blast conditions which occasion this effect include gas temperatures of about 3300°F. and blast velocities of 1600-2000 ft. per second, with the primary fiber diameter having a range of 0.002 to 0.007 inch.

To attain the complete or universal orientation the collecting means may be positioned at a sufficient distance from the blast as to permit the staple fibers to be jockeyed out of a straight line flow by eddies in the gases of the blast, thus the collecting means may itself preferably be a foraminous belt 50 mounted on pulleys 52, 54, and driven by suitable means (not shown) in the direction of the arrow (Fig. 1). A hood 56 may be positioned over the upper strand and a suction box 58 may be mounted at the end of the hood beneath the upper strand to draw the staple to the belt.

There were three claims and the following reference cited in this patent: 2,658,848, Labino, Nov. 10, 1953.

Manufacturing Rods of Glass Fiber-Reinforced Plastic. Patent No. 2,741,294. Filed May 18, 1954. Issued April 10, 1956. Three sheets drawings; none reproduced by Hans Pancherz.

A method of manufacturing rods of glass fiber-reinforced plastic is presented. A number of narrow bundles of glass fibers are continuously unwound from supply spools. The fibers are separately passed into a container filled with liquid plastic of the thermosetting low pressure curing type. With the fibers in parallel relationship and embedded in plastic they are then drawn into a steel molding tube, after which heat is applied to the tube to initiate hardening of the plastic accompanying the glass fiber bundles. A continuous rod consisting of glass fibers and the hardened plastic is drawn out of the tube and cut into desired lengths. Rods made by the process are said to have uniform strength and flexibility, in all directions of bending and may be produced efficiently at a high rate of production.

There were 4 claims and the following references were cited in this patent: 1,421,306, Rawlings, June 27, 1922; 2,625,498, Koch, Jan. 13, 1953, and 2,684,318, Meek, July 20, 1954.

Glass Compositions

Lead Glass Composition. Patent No. 2,736,714. Filed January 4, 1952. Issued February 28, 1956. No drawings. Assigned to Owens-Corning Fiberglas Corp. by Ralph L. Tiede.

Fibrous lead glass has applications in many fields, including the medical field. A chief use in this case is a fabric prepared from lead glass fibers and manufactured into a garment such as a gown or apron which is worn by physicians and radiologists as a radiation shield against penetrating X-rays and Roentgen rays.

An improved glass composition can be realized from the standpoint of forming products therefrom, especially

glass fibers, if the liquidus temperature can be lowered, or the temperature of the operating viscosity raised, or both. In such a case, the increased difference or "spread" between the liquidus temperature and the temperature of the operating viscosity greatly diminishes the dangers of devitrification. Desirable lead glasses for fiber drawing have been formed within the following composition limits:

SiO_2	30.0-37.0 per cent
PbO	57.0-65.0 per cent
Al_2O_3	2.00-5.0 per cent
Alkali oxide	1.5-7.0 per cent

The alkali oxide may be an oxide of an alkali metal found in group I of Mendeleeff's Periodic Table. The alkali oxides usually employed are sodium oxide and potassium oxide.

There were 3 claims and the following references cited in this patent: 1,943,051, Berger, Jan. 9, 1934; 2,431,980, Armistead, Dec. 2, 1947; 2,528,634, Armistead, Nov. 7, 1950; 2,623,549, Archer, Dec. 30, 1952, and 2,537, Great Britain, of 1855.

Ruthenium Containing Glasses and Stains. Patent No. 2,739,901. Filed July 14, 1952. Issued March 27, 1956. One page drawings; none reproduced. Paul G. Herold, Theodore J. M. Planje and John C. Williams.

This invention relates to the production of red coloration and black coloration in glasses and brown coloration in stains, and more particularly, to compositions containing ruthenium.

As examples of glasses, glazes, enamels and stains to which the inventions may be employed, the following compositions are given, the percentages of various compounds making up a composition being expressed in percentages by weight (see table below).

The intensity of coloration is controlled by the amount of ruthenium material added to the glass, glaze or enamel composition and ranges from a very light pink to a deep reddish-black in compositions I, II, IV and VI, shown in the above table, and ranges from a light gray to a true black in compositions III, V, and VII in the table. Composition VIII is an example of a ceramic stain which produces a brown coloration.

There were six claims and no references cited in this patent.

Electroconductive Article. Patent No. 2,740,731. Filed January 20, 1951. Issued April 3, 1956. No drawings. Assigned to Pittsburgh Plate Glass Company by William O. Lytle and Albert E. Junge.

According to the present invention, a novel indium oxide having a unusually high electroconductivity has been provided. This indium oxide is electroconductive and is preponderantly of indium oxide, but contains a small amount of fluorine. This product may be deposited upon a base, such as a transparent glass base by conducting the coating operation in the presence of fluorine, either in elemental state or as a metal or mineral fluoride compound which is soluble in or is miscible with the indium compound, such as water soluble fluoride.

It has now been found that many coatings so deposited have a specific resistivity below 0.001 ohm-centimeter, usually of the order of 0.0005 to 0.0009 ohm-centimeter. This electroconductivity is quite unusual and is far superior to that of the films which are deposited on soda-lime glass, such as window or plate glass, using other processes.

The invention is performed simply by heating the glass to an elevated temperature above 400°F. but below the temperature at which the glass begins to flow, preferably within the range of about 800 to 1200°F., and exposing the hot glass to the action of the indium compound and the fluoride. A typical solution which may be used according to this invention comprises an aqueous solution of indium chloride and hydrofluoric acid or a fluoride salt such as ammonium hydrogen fluoride ($NH_4F.HF$) or ammonium fluoride (NH_4F). This solution is sprayed upon the hot glass surface using a conventional spray gun and short periods of spray, for example, one or several seconds (usualy less than 10 or 20 seconds).

It is found advantageous to utilize a solution which is relatively concentrated as to indium chloride. Thus, it is rare to use a solution containing less than about 10 per cent by weight of indium chloride since such solutions

	(red)	(red)	(black)	(red)	(black)	(red)	(black)	(brown)
	I	II	III	IV	V	VI	VII	VIII
SiO_2	22.45	17.5	70.8	28.7	59.0	31.0	42.62	....
Al_2O_3	....	....	....	....	2.8	....	1.06	....
B_2O_3	....	17.5	7.0	....	10.9	....	....	....
PbO	73.91	65.0	....	65.0	....	40.8	14.70	....
Na_2O	....	....	5.4	....	9.7	10.1	11.00	....
K_2O	3.74	....	14.8	4.0	8.9	10.1	2.56	....
CaO	....	....	2.0	....	8.7	....	1.20	....
MgO	....	....	....	....	....	....	2.29	....
BaO	....	....	....	2.3	....	....	....	....
ZnO	....	....	....	....	....	....	1.10	....
SnO_2	....	....	....	....	....	8.0	....	....
Sb_2O_3	....	....	....	....	....	....	0.20	....
F_2	....	....	....	....	....	....	3.94	....
TiO_2	....	....	....	....	....	....	....	99.9
RuO_2	0.003	0.003	0.075	0.003	0.075	0.003	0.075	0.1

are unduly dilute and do not normally produce a satisfactory film. More concentrated solutions normally are used so long as the solution remains liquid. Preferably it is found advantageous to utilize solutions containing about 30 to 70 per cent by weight of indium chloride.

Adding a water soluble alcohol or aldehyde to the solution has been found advantageous. Such compounds are advantageous, since they appear to increase the conductivity of the film produced, reduce the amount of haze which tends to be developed in the film and further, to prevent or minimize tendency of the indium compound to precipitate. Typical alcohols which are found to be suitable include methyl alcohol, ethyl alcohol, isopropyl alcohol.

There were ten claims and the following references were cited in this patent: 2,021,661, Kisfaludy, Nov. 19, 1935; 2,118,795, Littleton, May 24, 1938; 2,429,420, McCaster, Oct. 21, 1947; 2,564,677, Davis, Aug. 21, 1951; 2,566,346, Lytle et al., Sept. 4, 1951, and *Materials and Methods Manual, June 1948*, Electroplated Coatings by George Black (pp. 93-99).

Reduced Glass Resistance Elements. Patent No. 2,743,196 Filed December 28, 1951. Issued April 24, 1956. No drawings. Assigned to Sprague Electric Company by Preston Robinson.

It is an object of this invention to produce small particle resistance units by a new process in such a manner that they have predictable electrical coefficients and characteristics.

The following example indicates the method used in coating the glass particles:

A ½" internal diameter tube 30" high was placed over a supporting manifold consisting of a gas inlet chamber, a packed gas distributive section and a 200 mesh supporting screen. 12 to 40 lbs. of glass particles consisting of 62 per cent. PbO, 33 per cent SiO_2, and 5 per cent Na_2O, having an average particle diameter of about 0.0224", were placed within the tube above the supporting screen. Hydrogen heated to approximately 285°C. was admitted to the bottom of the column so that it would pass through it at a velocity of about 0.837' per second. At this velocity the bed of particles expanded to a height of approximately 15.4", and each of the individual particles was surrounded by a thin film of gas and was subjected to a slight amount of agitation. The gas flow was increased to a velocity of about 0.869' per second at a gas pressure of about 110.1 lbs. per square ft. At this point the bed varied in length from about 15.45" to about 16.65". The same conditions of agitation persisted within the bed. The gas flow was continued for a period of 3 hours. At the end of this time the flow was stopped and the column of particles was allowed to slowly cool. The individual particles were then removed and employed as resistance elements.

There were 9 claims and the following references were cited in this patent: 2,339,928, Hood, Jan. 25, 1944; 2,365,720, Nieghbors, Dec. 26, 1944; 2,414,625, Abrams et al., Jan. 21, 1947, and 2,635,947, and Reed, Apr. 21, 1953.

Steel Alloy Blanks. Patent No. 2,745,738. Filed September 12, 1951. Issued May 15, 1956. No drawings. Assigned United States Steel Corp. by Freeman J. Phillips.

Certain modern industrial applications of metal-to-glass seals present a problem of considerable difficulty. One of these is the kinescope or television screen tube which usually comprises a metal cone, a glass disc overlying the large end thereof and a glass tube affixed coaxially to the small end. For such an application, the metal of which the cone is composed must have a thermal coefficient of expansion such that a wide variation in temperature, i.e., from about 2190°F., the temperature at which the seal is formed, to room temperature, will not fracture the glass as a result of differential contraction. After completion of the seal, the glass portion must not show substantial residual strain since such strain, if excessive, increases the danger of breakage by the shock or impact incident to handling and shipping. The metal, moreover, must have sufficient ductility to permit spinning the cone-shaped body of the tube from a piece of flat sheet. While certain known alloys have substantially the same coefficient of thermal expansion as the glass used to form the disc and small end of the tube, e. g., about $11X10^{-6}$ in./in.°C., they cannot be formed as by spinning. Conversely conventional steels having the requisite spinning quality cannot be employed because they oxidize too readily and have thermal coefficients differing too widely from that of the glass used for the receiving end of the tube.

It has been discovered that, in order to meet these requirements, not only must the composition of the steel be closely controlled to render it completely ferritic at sealing temperatures as high as 2190°F. (1200°C.) but the compositional ranges must be closely controlled to produce steel having a proper coefficient of expansion over the full range between room temperature and the foregoing sealing temperature of glass. To attain this desirable condition, the steel should have a coefficient of expansion very closely approximating that of the glass being utilized. It has been further found that such conditions can be achieved by very closely balancing the amount of carbon, chromium, manganese, nickel, silicon, aluminum and titanium as more fully described within the following limits:

	Per cent
Carbon	.005 to .12
Chromium	15 to 20
Manganese	Nil to 1.00
Silicon	Nil to 1.00
Aluminum	Nil to 1.00
Titanium	Nil to 1.00
Nickel	Nil to 1.00
Phosphorus	maximum, .04
Sulphur	maximum, .04

There were two claims and the following references were cited in this patent: 1,464,312, Fahrenwald, Aug. 7, 1923; 1,850,953, Armstrong, Mar. 22, 1932; 1,947,417, Holst, Feb. 13, 1934; 2,024,561, Becket et al., Dec. 17, 1935; 2,603,177, Gardiner, July 15, 1952, and alloys of Iron and Chromium, *High Chromium*, vol. II, pages 88 and 89. Edited by Kinzel. Pub. in 1940 by McGraw-Hill Book Co.

Metal Progress, June 1950, pages 761 to 764, inclusive.

(*Continued on page* 584)

Investigations of Stresses in Glass Bottles Under Hydrostatic Pressure Part II, Breakage Studies of Glass Bottles Under Internal Hydrostatic Pressure

Glass bottle breakage studies were conducted by Teague and Blau, *Journal American Ceramic Society, July 1956*, in an effort to correlate the information gained from the photoelastic studies reported in Part 1 (Research Digest, THE GLASS INDUSTRY, September 1956) with the actual performance of the glass prototype. It was also possible to observe the characteristics of glass bottles under internal pressure with respect to the location and orientation of breakage origins and fracture patterns in their relation to bottle design, wall thickness, and condition of the surfaces. The general method involved (a) securing a large number of bottles from a regular commercial production run of the three one-way beer bottles previously described, (b) measuring the dimensions of these bottles, (c) conditioning the surfaces of representative lots of each bottle design by various means, (d) pressure testing the prepared samples to destruction, and (e) studying the results to determine the pressure breaking characteristics.

One thousand bottles produced consecutively from the same mold cavity were selected during a regular production run of each of the three bottle designs. All bottles were selected at the cold end of the production lehr without bottle to bottle contact. They were packed successively in order of production in corrugated boxes with individual cells. Each group of one thousand bottles was then arranged in the test lots of 100 bottles each by putting every tenth bottle in the order of production in a test lot.

One lot of bottles was tested "as selected" and they were considered to be relatively pristine since they contained no obvious surface abrasions when removed at the cold end of the lehr. Another lot of bottles from each group was given simulative handling abuse far in excess of that which a one-way beer bottle should ever expect to receive in use. Such bottles are referred to as "abused". To study the effect of shape and design on the breaking characteristics of glass bottles under internal pressure, it was desirable to minimize the effects of possible variations in the condition of the pristine molded surfaces. This was accomplished by grit-blasting (No. 80 silicon carbide grit) the surfaces being studied.

A 100-bottle lot from each design group was measured to determine the diameter and thickness characteristics which were assumed to be representative of the entire group. Outside diameters were measured by a special dial micrometer gauge to the nearest 0.001 inch. Glass wall thickness measurements were made to the nearest 0.001 inch by means of a special dial micrometer thickness gauge. From these measurements thickness contour maps were made and used in studying the location and orientation of pressure breakage patterns.

All internal hydrostatic pressure tests were conducted on a Preston increment pressure tester. A summary of the internal pressure test results is shown in Table 1. The calculated average breaking pressures have been reduced by one-half of the test increment. The scattering of the test results in each case is measured by the coefficient of variation, which is the ratio of the standard deviation to the average expressed as a percentage.

TABLE I

Summary of Internal Pressure Tests on Glass Bottles

Bottle and Condition	No. of bottles	Avg. breaking pressure (lb./sq. in.)	Coefficient of Variation (Standard deviation/avg.)
12-oz. export (flow)			
Pristine molded	100	396.4	18.1%
Abused	100	274.8	11.9%
Grit-blasted			
Outer surfaces			
Side-wall origins	76	183.4	
Bottom origins .	24	195.0	
TOTAL	100	186.2	11.9%
Inner surfaces ...	100	104.2	13.1%
12-oz select (suction)			
Pristine molded	100	530.8	17.5%
Abused	100	266.8	14.2%
Grit-blasted			
Outer surfaces			
Bottoms only ..	100	240.4	9.1%
Overall	100	174.2	11.2%
Inner surfaces ...	100	124.0	15.6%
Quart select (suction)			
Pristine molded	100	381.6	22.3%
Abused	99	160.0	9.3%
Grit-blasted			
Outer surfaces			
Bottoms only ..	100	207.4	10.1%
Overall	100	131.8	9.6%
Inner surfaces ...	100	129.0	9.9%

A study of these results reveals the fact that bottles with so-called pristine molded surfaces are appreciably stronger than bottles with abused or grit-blasted surfaces, but the variation in strength is about twice that for nonpristine bottles. The pristine strength of groups of bottles such as these undoubtedly depends on inadvertent contacts which have been made with the surface. Furthermore, the pristine strength of a group of bottles apparently has little or no effect on the observed strength when abused. After very severe abuse to the outer surfaces there was a definite decrease in the pressure resistance of all groups of bottles, but even under these extreme conditions for a one-trip bottle they all showed sufficient strength for their intended use, and it is important to note that the variation in the strength of these bottles was greatly reduced. Grit-blasting lowered the strength even more than the severe abuse, and also the variability in strength was further reduced. When only

the outer surfaces were grit-blasted, the breakage originated in the side-wall and bottom as predicted by the photoelastic studies. Grit-blasting only the inner surfaces caused a still greater decrease in the strength of all three bottle designs.

A study of the location and orientation of pressure fractures showed that for bottles with pristine molded surfaces, fracture origins were located more or less at random on the shoulders, side walls, bearing surfaces and bottoms. Sidewall origins occurred in very thick areas as well as in thinner areas. A large number of origins occurred on the bearing surfaces since all bottles had been in contact with metal conveyors and the like in this area. The initial cracks of all fractures originating in the shoulders and side walls were vertical and in the bearing surfaces they were radial. In general, abused bottles broke in the areas of abuse, more particularly at the normal contact points of the upper and lower side walls near the shoulders and the heels. When the abuse at the heel and shoulder is relatively uniform, there appears to be some tendency for breakage origins to occur in the thinnest of these areas, although not consistently so. Less than 1 per cent of all the abused bottles tested broke in the bottom or bearing surface and no fractures originated in the extremely thick heel and lower side-wall areas of the quart bottles.

Uniformly grit-blasting the entire outside surfaces of pristine bottles apparently causes pressure breakage to originate in the areas of highest stress. Most breakage origins occurred in the side walls and shoulders, and there appeared to be a definite tendency under these conditions for breakage to originate in the thinnest portions of these areas. The pressure breaking characteristics of bottles grit-blasted only on the inside surfaces apparently depend on the size and contour of the inside bottom and heel areas as well as on the glass wall thicknesses.

Internal pressure of fracture patterns originating in various regions of bottles are remarkably consistent. The origins of the side-wall fractures are located on the outside side wall, in the center of a short, straight, vertical split which forks at each end in the form of a fan like network. All the forking is binary and in general the number of forks in each fan increases with increasing breaking stress. The initial fractured surface of the vertical split is normal to the bottle surfaces at the point of fracture, and the diagnostic markings on the fractured surfaces show that the cracks are propagated away from the origin with their leading edges on the outside surface. These same general fracture patterns occur when the breakage originates anywhere in the side wall and shoulder area up to the neck of the bottle. Even when the fracture is caused to originate on the inside surface of the side wall or shoulder, the pattern of cracks is the same, although the cracks are propagated with leading edges on the inside surface.

When bottles under internal pressure break in the bottom area, the fractures tend to originate on the outside surface near the center bottom, unless the center of the bottom is thicker and possibly arched up, in which case the fractures originating on the bottom surface may be displaced away from the center. Bottom-surface discontinuities may also cause displacement of the fracture origins in the bottom area. The initial fracture surface is normal to the surfaces of the bottom, and the ends of the initial crack may fork in the bottom or one or both ends of the crack may move up around the heel and into the side-wall area before fanning out.

When pressure breakage originates at the bearing surface, the initial crack is radial in direction in response to the maximum principal tensile stress which is circumferental, and the fractured surface is normal to the bearing surface. If such breakage occurs at a relatively low stress, the crack may extend itself across the bottom and around the heel to meet its other end and sever one large semi-circular portion of the bottom from the bottle. The initial crack across the bottom will be propagated with its leading edge on the outside surface, but then the ends of the crack turn horizontally around the heel and the fracture proceeds with its leading edge on the inside surface.

When bearing surface breakage occurs as the result of high internal pressure stresses, the initial crack is still radial in direction and normal to the bearing surface, but it may be in the form of a much shorter crack which then forks in fan-like fashion across the bottom while the other end of the crack moves up into the heel. When bottom cracks move up into the heel, they all make the characteristically sharp turn and propagation changes over to lead on the inside surface under the influence of the longitudinal tensile stresses. After the sharp turn at the heel the cracks may finally extend up into the side wall and fork into the typical fan pattern. Such fracture patterns were consistently developed in the pristine bottle which broke in the bearing surface at very high internal pressures.

One-way beer bottles such as these under consideration should retain their very strong pristine inside surfaces during use, and it should not be expected that pressure breakage origins would occur on the inside surface even under high test pressures. It was interesting and enlightening, however, to determine the general fracture characteristics of such bottles when the strength of the inside surface was greatly reduced by grit-blasting. When the breakage originated in the side wall, the origin of fracture was of course on the inside surface, and the fracture pattern was the same as the pressure breakage originating on the outer side wall.

Finally, it is important to note that internal hydrostatic pressure breakage should never originate in the outside heel area which is in compression or very low tension when under pressure. If such should seem to be the case, one should suspect and be able to identify obvious previous damage which extended through the glass wall into a zone of high tension caused by the applied pressure. Internal pressure breakage originating in the neck of a bottle is quite rare, since the tensile stresses are relatively low, and should therefore be associated with some obviously severe pre-existing damage. Thus when glass bottles are subjected to breaking pressures, the breakage should almost invariably originate on the outside surface in the side wall, bottom, or bearing surface.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during July, 1956 was as follows: *Flat Glass*: A preliminary figure of 29,000 for July indicates a decrease of 2.4 per cent from the adjusted 29,700 reported for June, 1956. *Glass and Glassware, Pressed and Blown*: A decrease of 6.7 per cent is shown by the preliminary 77,600 figure of July when compared with the 83,200 of June. *Glass Products Made of Purchased Glass:* The preliminary 14,100 indicates a decrease of 2.1 per cent from the previous month's 14,400.

Payrolls in the glass industry during July 1956 were as follows: *Flat Glass*: An increase of 0.9 per cent is shown in the preliminary $14,305,990 when compared with June adjusted $14,177,592. *Glass and Glassware, Pressed and Blown*: A decrease of 5.3 per cent is shown in the preliminary $27,442,464 reported for July when compared with the previous month's adjusted $28,936,880. *Glass Products Made of Purchased Glass*: A preliminary figure of $4,033,869 was reported for July. This is a decrease of 4.7 per cent compared with the adjusted figure of $4,230,720 for the month of June

Glass Container production, based on figures released by the Bureau of Census, was 13,290,000 gross during August, 1956. This represents an increase of 9 per cent from the previous month's production of 12,203,000 gross. During August, 1955, glass container production was 13,109,000 gross or 1.4 per cent under August this year. At the end of the first eight months of 1956, glass container manufacturers have produced a total of 96,972,000 gross. This is 5.6 per cent over the 91,826,000 gross produced during the 1955 period.

Shipments of glass containers during August, 1956 increased 41 per cent to reach 15,998,000 gross. This is an increase from July, 1956 shipments which were 11,396,000 gross. Shipments during August, 1955 were 14,604,000 gross or 8.8 per cent over August 1956. At the end of the first eight months of 1956, shipments have reached a total of 95,074,000 gross, which is 4.5 per cent over the 90,864,000 gross shipped during the corresponding period last year.

Stocks on hand at the end of August, 1956 were 13,685,000 gross. This is 21 per cent below the 16,518,000 gross on hand at the end of July, 1956 and 3.2 per cent higher than the 13,263,000 gross on hand at the end of August, 1955.

Automatic tumbler production during July, 1956 was 4,437,458 dozen. This is a loss of 5.6 per cent against the June, 1956 production, which was 4,700,778 dozen

Shipments during July, 1956 dropped to reach 4,276,153 dozen. This is 22 per cent lower than the 5,222,159 dozen shipped during July, 1955. At the end of the twelve months period ending July 31, 1956, shipments have reached a total of 60,315,537 dozen, which is a 2.1 per cent decrease from the 61,587,975 dozen shipped last year.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware during July, 1956 reached 2,279,183 dozen. At the end of the twelve month period ending July 31, 1956, manufacturers had sold a total of 35,803,334 dozen, which was 4.5 per cent lower than the 38,424,889 dozen during the corresponding 1955 period.

• David O. Berke has been appointed manager of quality control for the Technical Products Division. He succeeds Martin E. Dykeman, who was appointed sales engineer, western region, for railroad and industrial, appliance and optical sales.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

Narrow Neck Containers

	August, 1956
Foods	2,236,000
Medicinal and Health Supplies	1,718,000
Chemical, Household and Industrial	1,088,000
Toiletries and Cosmetics	1,010,000
Beverage, Returnable	572,000
Beverage, Non-returnable	111,000
Beer, Returnable	265,000
Beer, Non-returnable	997,000
Liquor	888,000
Wine	454,000
Sub-total (Narrow)	9,339,000

Wide Mouth Containers

Food	*5,015,000
Medicinal and Health Supplies	529,000
Chemical, Household and Industrial	224,000
Toiletries and Cosmetics	226,000
Packer's Tumblers	123,000
Dairy Products	303,000
Sub-total (Wide)	6,420,000
Total Domestic	15,759,000
Export Shipments	239,000
TOTAL SHIPMENTS	15,998,000

*This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production August 1956	Stocks August 1956
Foods: Medicinal and Health Supplies; Chemicals, Household and Industrial: Toiletries and Cosmetics	Narrow Neck	5,363,000	5,242,000
	Wide Mouth	*4,807,000	*4,122,000
Dairy Products		238,000	275,000
Beverages, Returnable		597,000	1,320,000
Beverages, Non-returnable		92,000	223,000
Beer, Returnable		180,000	305,000
Beer, Non-returnable		817,000	558,000
Liquors		713,000	945,000
Packers' Tumblers		101,000	160,000
Wines		382,000	535,000
TOTAL		13,290,000	13,685,000

*This figure includes Fruit Jars and Jelly Glasses.

New Equipment and Supplies

CRT NECK SPLICING MACHINES

Kahle Engineering Company, 1400 Seventh Street, North Bergen, New Jersey recently announced the availability of a series of splicing machines for cathode ray tube applications.

Typical of these precision machines is the #1545, which was specifically designed for salvage operations in cathode ray tube production. Basically, this machine consists of vertical lathes having two concentric and synchronous chucks whose special design gives automatic self-centering to eliminate costly, time-consuming adjustments.

Complete technical information on Kahle's line of CRT neck splicing machines is given in the company's machinery reference file and may be obtained direct from Mr. Eli Stiefel at the company.

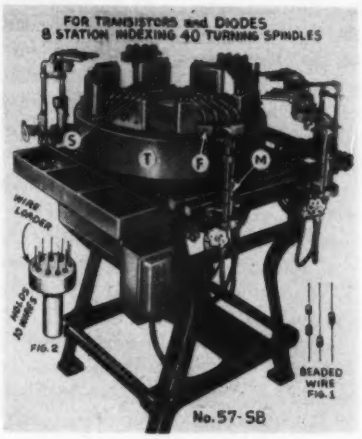
STANDARD OXY-ACETYLENE APPARATUS IDEAL FOR SHAPING GLASS

In glass plant operations, such as polishing and cutoff, single valve flame regulation for low pressure blowpipes can be easily set by any machine operator. Furthermore, glass plant engineers can more readily control product quality with this method of regulation. Flames can be reset exactly from shift to shift and from day to day, and expensive gas proportioning equipment is not required. These observations were made at a meeting sponsored by Linde Air Products Company, a Division of Union Carbide and Carbon Corporation, at the Severs Hotel in Muskogee, Oklahoma, for management and engineering personnel from the Corning Glass Works, Muskogee, Oklahoma, and the Liberty Glass Works, Sapulpa, Oklahoma.

In addition, the operation of medium and low pressure blow-pipes was demonstrated. Discussion centered on the high-speed flame-cutoff of glass tubing, on moil air quench flame-cutoff (Linde's patented process), and on Linde's recent development—intermittent fire-polishing for beverage bottles.

During the discussion of intermittent fire-polishing, it was revealed that the process produces a superior fire-polish for the entire production run of beverage bottles. The process also cuts maintenance costs and reduces the amount of heat in areas around bottle making machines, thereby making working conditions more comfortable for operators.

GLASS BEADING MACHINE FOR WIRE



The Eisler Engineering Company, Inc., of Newark, New Jersey has developed an improved machine for melting glass beads onto wire. The machine is claimed by Eisler to be the most productive machine of its type available to the industry.

It includes such features as: (1) A Turret (T) indexes intermittently by means of an 8 section Geneva Gear located on the underside of the Turret T. (2) Each of the 8 stations of this machine consists of a nest of 5 rotating spindles S. In addition to this, each rotary spindle accomodates 5 wires in the beading operation. This combination has a productivity of 25,000 wires per hour when the machine is operated at a speed of 500 indexes per hour. (3) The gas burners F using gas and air, provided the proper heat for melting the glass to the wire. Micrometer adjustment M makes possible accurate adjustment of the gas burner flames. (4) Figure 2 of the illustration shows the rotary spindles which is pre-loaded. Figure 1 shows a variety of beaded wires. One operator is required at the machine. Floor space is approximately 10 square feet and the machine is powered by a ¼ HP motor; all spindle heads are driven by spur gears.

BLENDED FLAME UNIT FOR GAS OR OIL FIRING WITH EXCESS AIR

Hauck Manufacturing Co., 124-136 Tenth St., Brooklyn 15, N. Y. has developed an effective means of utilizing excess air—up to 1000 per cent, to insure complete fuel combustion and obtain better circulation of heat at temperatures of 400° to 1800° F. in industrial furnaces, ovens, kilns and other heat processing equipment.

By diluting the high temperature combustion products by thoroughly blending them with excess air, these products are increased in volume, while their average temperature is reduced. Thus, with this expanded volume of gases, circulation and distribution of heat is improved, with greater uniformity of temperature throughout the heating chamber. Localized hot spots which occur in the use of relatively smaller volume of undiluted, high temperature products of combustion are avoided. Moreover, because of the wide range of temperatures which can be produced there is greater flexibility in the operation of the heating equipment, enabling its use for different kinds of work.

The unit is designed to assure a stable flame and prevent the entry of excess air from interfering with the ignition and combustion of the fuel within the refractory tile. The excess air flow is outside of the tile, so that blending takes place only at the tile outlet and periphery of flame. The path of the excess air is as straight as possible in the blending stage. Thus, combustion goes to completion before complete blending takes place. This reduces the formation of aldehydes, noxious fumes, smoky haze and objectionable odors.

The Hauck Blended Flame Unit consists of a cast iron mounting head and plenum chamber with inlet for blending air, burner mounting bolts, and a refractory ignition tile within a stainless steel shell.

CATALOGS RECEIVED

Colorado Fuel and Iron Corporation, Wickwire Spencer Steel Division, 575 Madison Avenue, New York, N. Y., have recently issued a new four-page folder describing CF&I-Wissco Lehr belts for glass annealing and decorating. The illustrated folder describes the special design features of Wissco Lehr Belts.

Kahle Engineering Company, 1400 Seventh Street, North Bergen, New Jersey, offer a new series of eleven informative two-color specification sheets describing many of Kahle's special automatic and semi-automatic machines. These spec sheets explain with illustrations the main operation, overall dimensions, uses and adaptability of each equipment. Write to Mr. Stiefel at the company.

Cords in Glass . . .

(*Continued from page* 557)

ties in thickness and partly to variations in the refractive index of the glass. The thickness effects are caused both by forming operations on uniform glass and by viscosity variations due to non-uniform glass, that is, to inhomogeneity. On the other hand, the pertinent index variations are due entirely to composition variations. For example, enrichment in silica or alumina decreases the refractive index of soda-lime-silica glasses, whereas enrichment in soda or lime increases it. This distortion may be studied conveniently by viewing the ware against a background of alternate light and dark stripes (Seddon 1937b), or by the use of "shadow-graph" devices (Spencer and Badger 1924; Holland, Preston, and Turner 1942). The last workers also discussed the examination of glass in the form of polished plates so as to eliminate surface irregularities, thereby allowing evaluation of the amount and distribution of cords within the glass. Immersion of the ware in an appropriate liquid (such as monochlorobenzene) which matches the glass in index, likewise eliminates the effects due to surface irregularities.

The visibility of cords in the ware depends upon the amount and distribution of the cords and also upon the composition variability involved. In general, cords arising from contamination with foreign materials are likely to be off color, and to show the effects of high viscosity in the molten state. These cords, therefore, will usually be more noticeable to the eye than will cords due to simple misproportioning of the normal batch constituents. Either of these two types, however, may affect the "striking" properties of opal glass thus causing streaks of relatively clear glass. Another exception to the foreign-contamination origin of colored cords is the light-colored streak in amber ware which arises from the combination of misproportion of the normal glass oxides together with unusual localized firing conditions. Still another exception would be the amber streak in flint glass which, reputedly, can be caused by localized carbon contamination. Although such carbon streaks might theoretically be possible, they would not be persistent. To the contrary, however, all amber streaks which we have studied have resulted from attack on aluminous refractories, and have been very persistent.

Most colored cords, nevertheless, do originate from foreign materials containing metallic coloring agents, and thus are strongly influenced by the oxidation-reduction conditions in the melting process. Such coloring effects, which are powerful diagnostic tools, were discussed by Dietzel and Springer (1936b), Fabianic (1944), and Knight (1947) in articles dealing with glass stones. In a later book, Taylor and Hill (1952) discuss especially thoroughly the colors and viscosity and stress effects associated with cords, and much of the cords and stones from refractories does come from such attack. Aluminous cord can usually be distinguished from silica ones by the amber or greenish-amber colors in the aluminous cords in contrast to the slight coloring in silica ones.

Such refractory attack usually involves considerable viscosity increase in the molten glass. Cords with high viscosities are often characterized by ridges or blobs on the internal surfaces of the ware or by fine lines, "cat

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scratches", on the mold side. Such cords usually are a result of attack on silica or alumina-silica refractories, or may arise from silica scum. Poole, in his series of papers (Poole 1949a, b; Poole and Gensamer 1949) dealing with viscosities in the annealing range, studied composition-viscosity effects thoroughly on soda-lime-silica glasses bearing various amounts of alkaline earth oxides and alumina. He presented simple equations for calculating the temperature-composition effects at given viscosities. These show, for example, the effect of composition upon the annealing or softening temperatures.

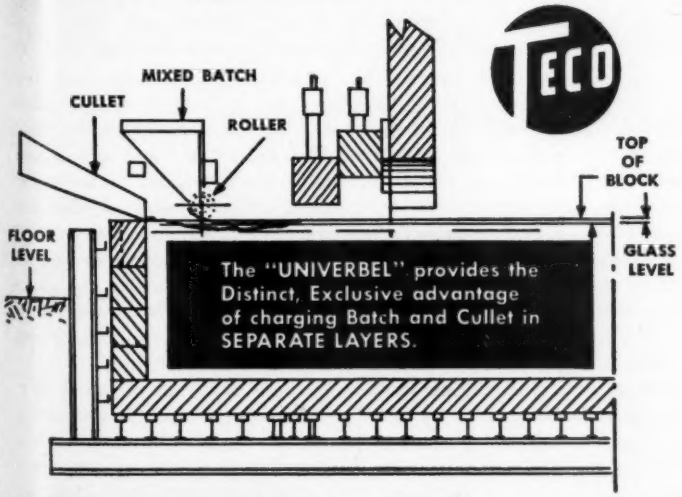
IC2. Associated Stones

Stones imbedded in cords or associated with them can can be a great help in the determination of the source of the cords. Such stones can either originate in the source material and come through the furnace with the cord glass or sometimes they can arise in severe refractory cords by devitrification of the melted cord glass after it has cooled somewhat during its passage through the refiner and flow channel. In either case, the crystalline substances in the stones will give clues to the origin of the cord; although, very rarely, extreme concentrating of a minor component may occur in stones. Often, the stones give very valuable clues. Thus, cords originating in zirconia-bearing aluminous refractories are likely to contain devitrification crystals of zircon and corundum. Attack on aluminous refractories yields reaction products such as nephelite, mullite, or corundum. Any stones with indices less than that of the glass must be silica. Silica stones such as residual quartz grains, usually imply trouble with batch sand, although quartz can also occur as a result of attack on silica brick. Wedge-shaped twins of tridymite indicate direct inversion of quartz crystals, whereas tridymite formed by devitrification occurs in the form of dendritic growths (with 60° angles), or hexagonal plates, seen on edge as needles or laths. The crystal forms of cristobalite, however, are of little help in identifying sources of cords.

The petrographic study of glass stones has been dealt with in many published articles. The selected references in the paper by Knight (1947) survey the literature to that time. The table of mineral properties given there was amplified in the HANDBOOK OF GLASS MANUFACTURE (Knight 1953a), where a tabulation of sources of stones is also given (Fabianic 1953b). Rigby (1948) has discussed "The Thin-Section Mineralogy of Ceramic Materials", and Jebson—Marwedel (1951) has published photographs of glass melting including numerous examples of glassy and of crystalline heterogeneities. Taylor and Hill (1952) are especially thorough in their discussion of glass stones, and of their relationships to cords, showing numerous pictures. Seddon (1948) refers to the separation stone crystals from glass by sink-float methods. Lyle (1952) emphasizes the sources for stones and cord glass with thorough discussion of refractory attack. He points out that a large majority of stones come from attack occurring above the glass line.

(*Continued on page* 572)

Better Glass with 'UNIVERBEL' Batch Charger



The unique "Univerbel" Batch Charger for feeding batch and cullet to glass melting furnaces was developed and perfected in Belgium and is being used with exceptional success in many European countries as well as Great Britain, Canada and the United States.

It is ideally suited for charging melting furnaces in plants producing WINDOW GLASS, PLATE GLASS, CONTAINERS, GLASS BLOCK, GLASS WOOL, GLASS FIBER and many other materials and products.

◀ Illustration at the left shows the "Univerbel" charger in a sectional drawing of the doghouse into which the batch and cullet are fed by the charger. Rotation of the Feeding roll moves the batch and cullet into the furnace.

Write or Phone FOR FURTHER INFORMATION

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(*Continued from page* 571)

ID. Thermal Expansion

ID1. Development of Stresses in Cords

Internal tension and compression stresses which arise in cordy glass are a result of differences in thermal expansion between the cords proper and the matrix glass. At the high temperatures of melting and working, both the cord and the matrix glass have the loose atomic structure characteristics of liquids. They yield or flow under any applied stress (force) and therefore cannot support a condition of internal strain (distortion). But since the cord and the matrix glass differ in chemical composition, they also differ in their coefficients of thermal expansion at any given temperature, and in their softening range. So as the cordy glass cools, its various portions contract at different rates, and each portion influences, and is influenced by, adjacent portions. This gives rise to internal stresses which in turn cause atomic strains. These strains in turn cause birefringence effects which become visible in polarized light. Now we are interested primarily in the cord's effects upon the strength of the ware. Hence, we shall herein refer simply to the stresses in and around the cords, realizing that what we actually observe in the polariscope or microscope is the strain birefringence made visible by the polarized light.

If a cord has a higher expansion coefficient than the adjacent matrix glass, its normal contraction on cooling will be restricted by the smaller contraction of the matrix. At room temperature, then, the cord will be held under tension both transversely and along its length, and it will induce in the matrix glass longitudinal compression parallel to the length of the cord and transverse tension perpendicular to the cord. On the other hand, a cord with a relatively lower coefficient of thermal expansion will be under compression in the cold ware and will induce longitudinal tension and transverse compression in the matrix glass. Since these stresses arise because of the chemical heterogeneity, they cannot be eliminated by the physical process of annealing. The induced stresses in the matrix are less concentrated than are the cord stresses, and they gradually fade away with increased distance from the cord. In instances of compression cords, nevertheless, it is these induced tensions which may affect the strength of the glassware.

ID2. Relation of Thermal Expansion to Composition

Morey (1954) gives a very complete account of measurement on the thermal expansion of glasses. Attempts to establish "factors" for computing thermal expansion from chemical composition were reviewed by Sun and Silverman (1941). Their summary of some fifteen published articles revealed a wide divergence among the results of the various workers. Probably the most useful set of factors for typical soda-lime-silica glasses is that developed by the Owens-Illinois Glass Company (Silverman 1940). These were published in more complete form by Ghering and Knight (1944), and are also given in the HANDBOOK OF GLASS MANUFACTURE (Sharp and Badger 1953a). They are shown in Table VI herein. These are differential factors; that is, they are the changes in thermal expansion caused by an increase of one weight percent in the respective oxide.

TABLE VI

FACTORS FOR CALCULATING THE COEFFICIENTS OF LINEAR THERMAL EXPANSION OF COMMERCIAL SODA-LIME-SILICA GLASSES

(Factors are in in./in./°C per weight per cent.)

(1) Oxide	(2) (Factor) x 10^7	(1) Oxide	(2) (Factor) x 10^7
Na_2O	3.86	Li_2O	6.56
K_2O	3.20	BaO	1.08
CaO	1.36	SiO_2	0.28
CaO·MgO	1.10	Al_2O_3	0.24
MgO	0.73	B_2O_3	—0.60

Thus, we can calculate the thermal expansion change due to replacement of 1 per cent of silica by soda as follows:

Plus 1.0 per cent Soda:
$1.0 \times 3.86 \times 10^{-7} = +3.86 \times 10^{-7}$
Minus 1.0 per cent Silica:
$-1.0 \times 0.28 \times 10^{-7} = -0.28 \times 10^{-7}$
Net change $= +3.58 \times 10^{-7}$

There appear to be no similar set of factors for borosilicate glasses. Because these glasses have low thermal expansions, enrichment in any oxide except silica contributes to high expansion and leads to cords in severe tension. Hence, for a cord in borosilicate glass to be under compression, it would have to be rich in silica alone.

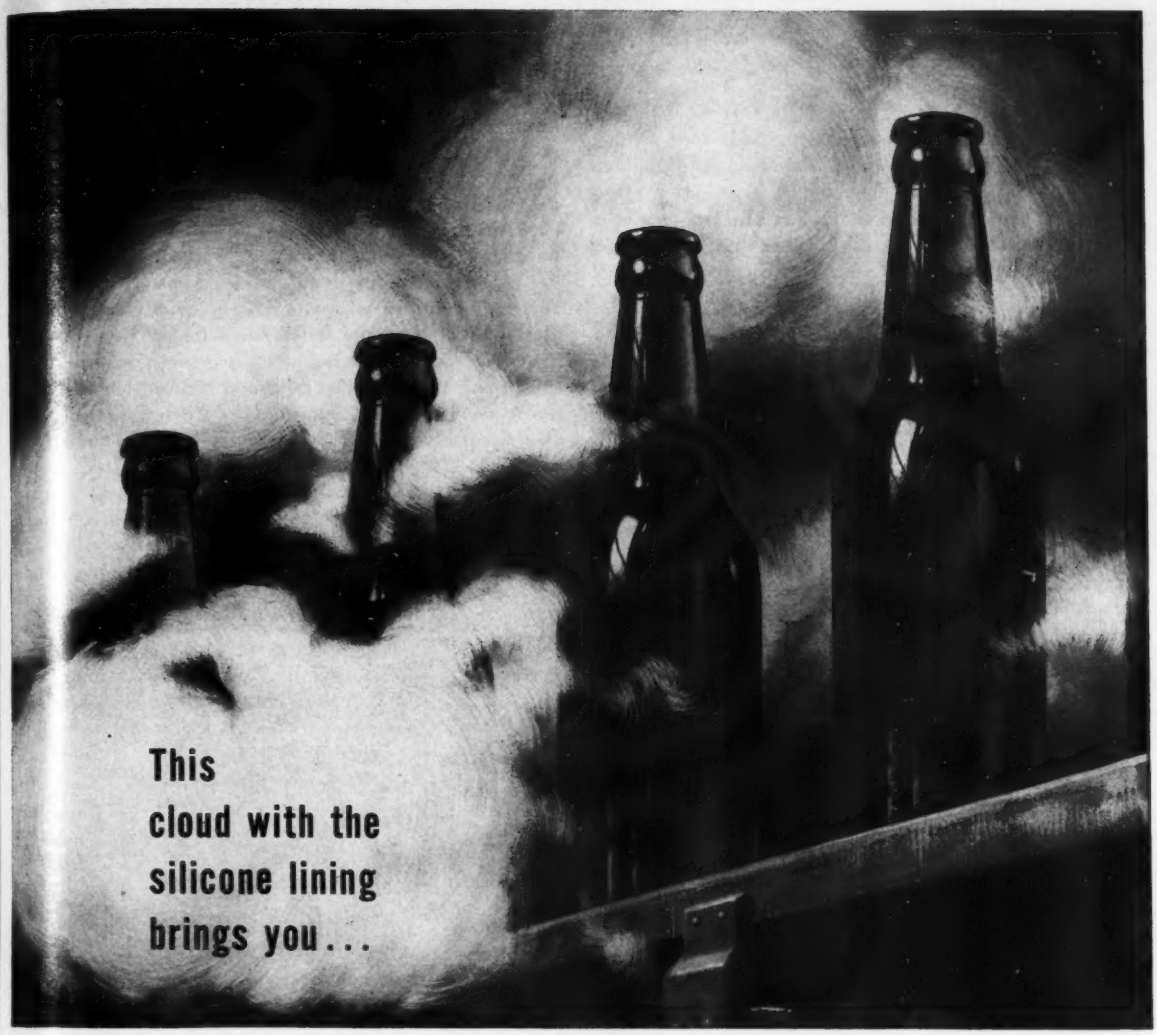
IE. Optical Properties in Polarized Light

IE1. Polariscopes

Cords may be detected by observation of glassware in polarized light, using crossed sheets of polarizing materials, because of the birefringence effects discussed above. Two general types of polariscopes are used. Each type has its specialized uses, and both are of value. In one type, the samples are examined in air; this has the limitation that refractions and reflections at the glass surfaces interfere somewhat. In the second type, the ware is immersed, in a stress-free, flat-walled tank, in a liquid which has about the same refractive index as the glass (such as monochlorobenzene). This greatly reduces the disturbing effects just mentioned. Either type can be equipped with low magnficiation, tint plates, or stress-measuring devices. For comparative stress measurements on glass containers the G.C.A. Standard Discs (Green 1945; Holland 1945) are very useful. Their use has been discussed by Gooding (1938, 1940).

The ASTM (1950b) recommends the use of the "Polaroid" polariscope and the Standard Discs in the evaluation of glass containers. Swicker (1942) gives a useful review of these techniques. Gallup (1944) described an instrument which offers especially complete polarization by utilizing reflection as well as "Polaroid" film. Fortey (1945) described a projection polariscope having a magnification up to 12X. For further discussions of polariscopes in the glass industry, see articles by Preston (1930, 1934), Lester (1932), Beeton (1938), Monack and Beeton (1939), Monack (1940), Swicker (1939), Nolti (1943), and Balmforth and Holland (1945).

(*Continued on page* 574)



LOW COST ANTI-SEIZE TREATMENT

Glass container manufacturers are fast turning to UNION CARBIDE silicones to reduce bottle breakage. Sprayed on as a fog or mist right in the lehr, these powerful anti-seize agents impart excellent lubricity to the outer surfaces of containers.

The cost of silicone anti-seize treatment is low—more than offset by savings in the costly and troublesome breakage that can occur during handling and filling. The first step is the preparation of a 0.5 to 1.0% aqueous solution of the UNION CARBIDE anti-seize agent. This water-like liquid is then applied as a fine mist in the lehr, using fogging equipment supplied by many reputable manufacturers. The result . . . a light even coating that insures a shiny, attractive container.*

The glass industry also depends on the "slipperiness" and water repellency of UNION CARBIDE silicones in another phase of production. They help produce sparkling bottles with fewer rejects when used as a lubricant on molds, shear blades, and chutes. Less soot, less smoke . . . working conditions are vastly improved.

*Contact *Silicones Division* engineering staff for advice and service on the proper use of silicone anti-seize agents in your plant. *And,* be sure to ask them about X-520 for anti-seize treatment of food containers.

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Cords in Glass . . .

(*Continued from page* 572)

IE2. Polariscopic Appearance of Cords

Whatever the type of polariscope used, cord stresses must be distinguished from stresses due to incomplete annealing. The size of the cord and its distribution in the ware affect its visibility in the polariscope in somewhat the same manner as they affect its appearance to the naked eye. Highly stressed cords, of course, show more birefringence for a given size than do weakly stressed ones, and, for equal stresses, larger cords stand out more prominently than smaller ones. This dependence of visibility on size complicates the problem of estimating the severity of cord stresses in a piece of glassware by simple observation under the polariscope. Methods have been developed (Swicker 1939, 1953; Anon. 1944) for the measurement of maximum stresses in ring sections cut from the ware. These greatly help the commercial evaluation of cord stresses.

Almost all cords found in glassware formed by drawing, pressing or blowing occur as flattened and elongated layers that are approximately concentric with the curvature of the glass in which they are imbedded. Hence, when the uncut ware is observed in an air polariscope, the line of sight is parallel to the thickness, or shortest dimension of the cord, i.e., radial with respect to the ware. In the immersion polariscope, a tangential view of the cord can also be obtained, with the line of sight usually parallel to the cord's width and perpendicular to its length and thickness. When a ring section taken across the length of the cord is examined under the polarizing microscope, the line of sight is longitudinal, being parallel to the cord length and perpendicular to its width and thickness. Thus a cord may be viewed radially, tangentially, or longitudinally.

IE3. Stress Patterns in Cords

The stresses in and around the cord can be resolved into three mutually perpendicular components, corresponding to these three major directions. It is to be remembered here, moreover, that stresses visible in any given line of sight can always be resolved into two mutually-perpendicular components in the plane perpendicular to this line of sight. That is, stress components in this line of sight can have no polariscopic effects. Hence, if a cord is viewed along any of the three major directions, only those stresses having components in the other two major directions can contribute any polariscopic effects. Rotating the ware around the line of sight will show the positions of the maximum visible stresses. One additional general relationship is that compression in one direction gives polariscopic effects identical with those due to tension at right angles to the compression.

Along the center line of a long, flat, ribbon-like cord in thin ware, only tangential and longitudinal stresses are present, since the thin glass is relatively free to expand and contract radially. Near the edges of the cord, however, radial stresses are present along with these others. When a *tension* cord is viewed *radially*, the longitudinal compressions and tangential tensions induced in the matrix glass on either edge of the cord reduce polariscopically to longitudinal compressions. These are opposed by longitudinal tensions in the cord itself, and these also are visible in the radial view. These longitudinal tensions overpower visually the weaker transverse tensions in the cord. In that part of the field of view lying within the cord boundary, the tensions and compressions induced in the matrix glass before and behind the cord are nullified polariscopically by opposing stresses in the cord glass. Thus, viewed radially, the cord appears to be under longitudinal tension only and to induce longitudinal compressions in the adjacent matrix glass. Conversely, a *compression* cord viewed *radially* exhibits longitudinal compression and induces longitudinal tensions in the matrix. An exception to this is the so-called "onion skin" cord which extends as a sheet concentrically around the ware. Here these edge effects are not present, and such a cord cannot be seen by radial observation of the ware.

If any flattened cord, either ribbon-like or "onion skin", is viewed *tangentially* in an immersion polariscope, the radial and longitudinal stress components cause visible effects. A *tension* cord, for example, shows longitudinal tension, and the matrix glass adjacent to both faces of the cord exhibits longitudinal compressions, and conversely with *compression* cords. When any flattened *tension* cord is viewed in a ring section, *longitudinally*, the tangential stresses cause the cord to show tangential tensions and induce tangential compressions in the matrix glass beside the faces of the cord. At the sharp edges of the cord, moreover, the radial and tangential stresses cause the tension zone to extend for some distance into the matrix glass in a direction approximately parallel to the cord's flattening.

Thus, a *tension* cord is found to be under tension in all directions, and to induce in the adjacent matrix glass longitudinal compressions at the edges and tangential compressions at the faces of the cord. Similarly, *compression* cords exhibit internal compressions and induce tensions in the adjoining glass.

COLUMBIA-SOUTHERN MAKES TECHNICAL APPOINTMENTS

Appointment of H. C. Twiehaus as assistant technical director for Columbia-Southern Chemical Corporation has been announced by Joseph A. Neubauer, vice president and technical director. Columbia-Southern is a wholly-owned subsidiary of Pittsburgh Plate Glass Co.

Also announced were the appointments of Francis W. Theis as manager of the planning department and Kenneth W. Richardson, Jr., as director of the development department. Mr. Twiehaus formerly had served as manager of the planning department since his transfer to Columbia-Southern's Pittsburgh headquarters in 1954. He has been associated with the firm since 1940.

Mr. Theis transfers to Pittsburgh from Barberton where he had served as director of the development department since 1952. He joined Columbia-Southern as a development engineer in 1941 and has spent the past 15 years serving in various supervisory capacities.

Mr. Richardson had served as assistant director of development at Barberton since 1953. Associated with Columbia-Southern since 1946 when he joined the Barberton plant as a development engineer, Mr. Richardson has since held several supervisory positions in the plant's development department.

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FISCHER & PORTER APPOINTS DIRECTOR OF GLASS RESEARCH

Fischer & Porter Co. announces the appointment of Oscar H. Grauer as director of Glass Research. This is a new position created to supervise the company's increasing use of precision glass, both as items in the company's laboratory apparatus line and as components of instruments. Investigations into the strength of glass, new glass compositions and new methods of glass reforming and fabrication will be conducted.

For the past two years, Mr. Grauer has served as glass technologist in Fischer & Porter's Glass Division. His developments include new techniques in the devitrification, fabrication, and annealing of precision glass.

Mr. Grauer was previously employed at the National Bureau of Standards. During World War II he was a supervisor in the Bureau's optical glass plant. He prepared hundreds of different glasses, measured their physical properties, and authored several papers based on these investigations.

WESTVACO CHLOR-ALKALI MERGES RESEARCH WITH COMMERCIAL DEVELOPMENT

Commercial development activities of Food Machinery and Chemical Corporation's Westvaco Chlor-Alkali Division have been moved from New York to the Division's largest plant at South Charleston, West Virginia. Mr. Franklin Farley, division president, announced that the consolidated commercial development and research group is now operating at South Charleston under the direction of Mr. William B. Rose, former development manager and now manager of research and development.

Robert R. Dean, former manager of market research, becomes director of the market section of FMC's Westvaco Chlor-Alkali research and development department, handling market research and market development responsibilities. He is chairman of the Chemical Market Research Association's statistical committee and a member of the Commercial Chemical Development Association's publication committee. He joined Westvaco in 1953.

Dr. Charles H. Braithwaite has been named laboratory section director of FMC's Westvaco Chlor-Alkali research and development department. He joined Westvaco in 1951, having previously been with Westinghouse Electric and with the Shell Oil Company.

Al G. Draeger becomes director of the engineering section of FMC's Westvaco Chlor-Aakali research and development department. He was with the Victor Chemical Works before joining Westvaco in 1946.

Albert Anson, Jr. is named manager of the consolidated laboratory services for FMC's Westvaco Chlor-Alkali research and development department. Mr. Anson was with the Pennsylvania Salt Manufacturing Company before joining Westvaco in 1940.

DONALD L. McCLURE DIES AT 49

Donald L. McClure, 49, recently-appointed General Manager of the Corrulux Division of the L-O-F Glass Fibers Company, collapsed and died of a heart attack on September 14th in Houston, Texas. He had left Toledo only a few weeks before to take up his new duties. Mr. McClure had been associated with the glass industry for 20 years.

Surviving are his wife, Doris Angevine McClure; daughter, Sharon Lynn; mother, Mrs. Martha McClure, 84, a member of the pioneer Consaul family of East Toledo; sisters, Miss Catherine McClure, Mrs. Colinne Anderson, Mrs. Margaret Chuckovits, Mrs. Marthabelle Holland and Mrs. May Thielman, all of Toledo, and brothers, Lewis McClure, Monroe, Michigan, and Richard A. McClure, Toledo.

Services and burial were held in Toledo.

CORNING GLASS APPOINTS F. J. FARNCOMB

Appointment of F. James Farncomb as senior research associate in chemistry at Corning Glass Works was announced by Dr. William H. Armistead, company vice president and director of the Research and Development Division.

Mr. Farncomb is in charge of chemical analysis in the Division's technical service research department.

In making the appointment, Dr. Armistead pointed out that only five other company scientists now hold the senior research associate title which the company awards for outstanding scientific achievement.

Dr. Armistead praised especially Mr. Farncomb's many contributions to the development of new and improved analytical processes used extensively by the company's technical service staffs. He said Mr. Farncomb is widely respected for his knowledge and experience in this field.

CANADIAN NEWS

There were 8,726 employees regularly engaged in Canada's glass and glass products industry on June 1st this year and their average weekly salaries and wages advanced to $66.19 on this date in contrast to $65.01 a year earlier, according to the latest survey of such manufacturers by the Canadian Government.

The average hourly earnings of such workers reached 149.9 cents on June 1st from 145.1 cents a year earlier and the average hours of work per week fell to 42.3 from 43.0. In addition, the industry reported 7,174 regular wage-earners on June 1st and their average weekly wages increased to $63.41 from $62.39 last year.

Employment in the Canadian glass industry showed a sharp rise since June 1st this year this index touched 137.5 in contrast to 134.0 on May 1st and 123.8 on June 1st a year earlier, based on 1949 being 100. Moreover, the proportion of men engaged in the glass industry declined since of the 8,726 regular workers on June 1st of this year, men formed 7,074 or 81.1 per cent and women 1,652 or 18.9 per cent, whereas a year ago men comprised 81.9 per cent and women 18.1 per cent of the labor force.

• P. R. Fibre Industries Ltd., was granted federal charter of incorporation by Secretary of State of Canada, Ottawa; the head office is to be in Fort Saskatchewan, Alta.

Petrographic equipment provides service for glass customers in stone identifications and in the study of raw materials and finished products.

Analyses in this new chemical laboratory help assure top performance of Laclede-Christy refractories—long life and economical service.

Complete testing facilities are constantly used to check refractory consistency and quality.

Laclede-Christy testing checks refractory quality from raw clay through all processing stages.

Refractory progress starts here

To aid refractory users—and to promote refractory progress—Laclede-Christy constantly searches for better ways to produce better products.

Refractories of the future will come from Laclede-Christy laboratories—as have refractories now widely used. Laclede-Christy developments include CAST 400 bottom blocks, CAST FLUXTITE, castable refractories, HKP super-duty silica brick, cast pot clay and other products.

Constantly high Laclede-Christy quality originates here, through research, analysis, checking and re-checking.

Laclede-Christy progress can be yours too. Are you using it?

HKP LACLEDE-CHRISTY COMPANY FOUNDED 1844

LACLEDE-CHRISTY DIVISION

H. K. PORTER COMPANY, INC.

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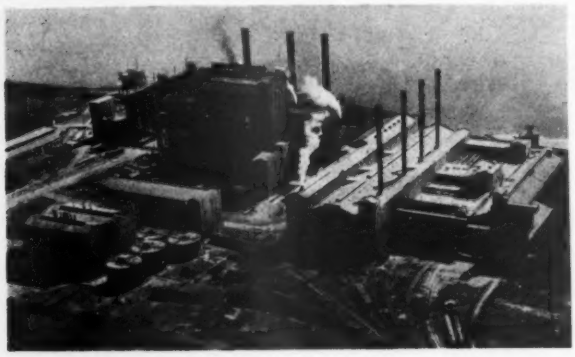
Milestones in Glass Progress

PHOTO COURTESY THE TOLEDO MUSEUM OF ART

1750 The glass stem on this engraved goblet typifies the style in vogue in England from about 1735 to 1760. The spiraling air lines were achieved by inserting air bubbles in a mass of the metal, and simultaneously elongating and twisting it. The air-twist stem became almost a national type of decoration.



1890 Michigan Alkali Company, now a division of Wyandotte Chemicals Corporation (North Plant, above), was founded by Captain J. B. Ford to supply Soda Ash to the glass industry. Wyandotte has grown up with glass. Today, as in the past, it is a working partner, supplying technical assistance and raw-material chemicals to those great companies marking milestones in glass progress.

Wyandotte
CHEMICALS

Michigan Alkali Division, Wyandotte Chemicals Corporation
Wyandotte, Michigan • Offices in principal cities

Founded by a Glassmaker to Serve the Glass Industry

OVERMYER MOULD CANCELS 1956 IRON CLINIC

The 1956 Iron Clinic planned for September 20th at Winchester, Indiana had to be cancelled due to a strike in the Miscellaneous Division.

All indications were that the eighth annual clinic would have had a record attendance this year. The Mould Making Department strike has been settled.

WINDOWS AND GLASS TOPIC AT BUILDING RESEARCH INSTITUTE CONFERENCE

The Building Research Institute will conduct a two-day research correlation Conference on "Windows and Glass in the Exterior of Buildings" at the United States Chamber of Commerce, Washington, D. C., on Wednesday and Thursday, November 14 and 15.

The purpose of the Conference will be to report on the newest and most interesting developments concerning the use of glass in the subject field and to correlate this information, to describe problems that exist in the use of windows and glass products and to propose solutions for these problems, and to identify research that needs to be done to achieve a better use of windows and glass in buildings. The Conference is open to the public.

Speakers will include architects and engineers nationally known for outstanding work with unusual amounts of glass, top technologists from the glass industry, university officials known for their work with glass and related technical fields, and men from research laboratories. Most are members of the Building Research Institute.

L-O-F NAMES NEW AIR CONDITIONING ENGINEER

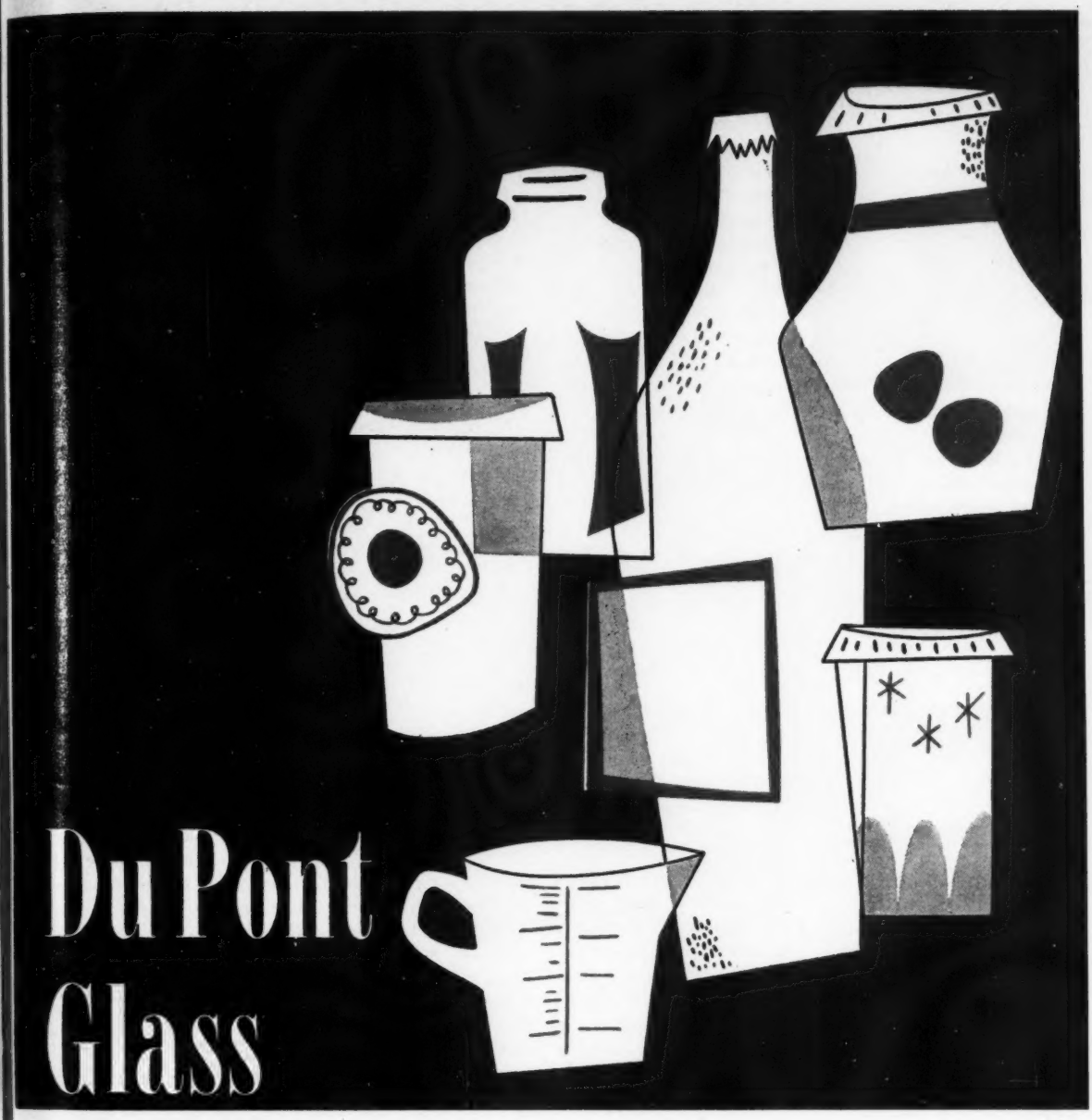
Donald J. Vild, research engineer who has specialized in design of large air-conditioning and heating installations, has been appointed a technical service engineer for Libbey-Owens-Ford Glass Company, it was announced by C. W. Davis, executive vice president — production and H. M. Alexander, general manager of research and development.

As a research engineer with the American Society of Heating and Air Conditioning Engineers' Research Laboratory in Cleveland for four years he worked almost exclusively on research dealing with heat flow through glass and he is co-author of four technical papers dealing with heat transfer through fenestrations. In the last year he was with the Austin Company, Cleveland, as an air conditioning design engineer.

"Mr. Vild will have as his major assignment for Libbey-Owens-Ford detailed studies of the effectiveness of Thermopane insulating glass in air-conditioned buildings, and will also work with other L-O-F research sections on studies of light and heat transmission through glass chiefly in relation to air-conditioning and heating problems," said Mr. Alexander.

In his new work here he will report directly to Frank Rodman, director of technical service, with offices at the L-O-F Technical Building.

• Mr. C. Caldwell, Rochester Institute of Technology, joins Glass Chemistry Section of Chemical Research Laboratories, Bausch & Lomb Optical Co.



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BALL BROTHERS APPOINTS W. R. BONE

Appointment of W. Russell Bone of Lancaster, O., to the newly-created position of assistant to the executive vice president of Ball Brothers Company Incorporated, was announced.

Formerly general factories manager of the Anchor Hocking Glass Corporation Package Division, Mr. Bone resigned that position to join Ball. The Muncie firm is engaged in the production of glass, metals, rubber, plastics, paper, and electronics products.

Mr. Bone will be concerned principally with matters of manufacturing and sales of glass products, according to the announcement.

The new Ball executive was with Anchor Hocking and predecessor companies for 28 years, the last seven years of which he was general factories manager of their four glass container plants. Before that he had filled various production management assignments.

R. A. MILLER RETIRES

Robert A. Miller, one of the glass industry's top authorities, retires this month after 35 years service with Pittsburgh Glass Company.

Mr. Miller joined the firm during 1921 and was associated in the development of many of the company's specialty products. For a five-year period he served as assistant superintendent at the Creighton, Pa., plate glass plant.

Since 1930, Mr. Miller has served as a technical sales engineer and has been a member of the glass division's product development department since it was organized in 1944.

A graduate of Yale University and the Massachusetts Institute of Technology, Mr. Miller is a member of and has held numerous offices in such organizations as the American Chemical Society, the American Society of Mechanical Engineers, the American Ceramic Society and the American Society of Heating and Air-conditioning Engineers.

EXECUTIVE APPOINTMENTS AT UNITED STATES BORAX & CHEMICAL CORP.

Pacific Coast Borax Company Division of United States Borax & Chemical Corporation has announced the appointment of Mr. Lloyd L. Fusby as Western manager, and Mr. Roger W. Hinchman as general sales manager.

Mr. Fusby is a chemical engineer, having graduated from the University of California in 1935. He has progressively been superintendent of the Boron Plant, production manager, and he will now have over-all responsibility for production at both Wilmington and Boron, as well as related activities of the division.

Mr. Hinchman, also a University of California graduate in 1935, has been with the Company since 1941. Until his present appointment he has been in various sales positions, including eastern industrial sales manager. Now he will have over-all charge of the division's Industrial and Agricultural Departments, both East and West.

In making these two appointments Mr. J. F. Corkill, vice president and general manager, announced Mr. Fusby will continue to make his headquarters in Los Angeles and Mr. Hinchman will remain in the Division's headquarters in New York.

HARSHAW EXPANDS MANUFACTURING OPERATIONS OVERSEAS

The Harshaw Chemical Company of Cleveland, Ohio has established a wholly-owned English subsidiary, Harshaw Chemicals Limited, with offices, manufacturing plant and laboratories at Waltham Cross, London, England. The new unit was formed primarily to supply electroplating chemicals and processes for the British Isles. Other chemicals manufactured by the parent company are expected to be added as markets are developed.

Mr. A. C. Benning, long active in the manufacture, sale and service of electroplating chemicals at the home office is manager of the new unit. Mr. S. E. Pross, Hounslow, has been made assistant general manager. Among Mr. Pross' former connections was a tour of duty for the Kuwait Oil Company in the Persian Gulf area.

WESTVACO CHLOR-ALKALI RESEARCH STAFF

New assignments in the research and development department of Food Machinery and Chemical Corporation's Westvaco Chlor-Alkali Division at South Charleston, West Va., have been announced by Dr. C. H. Braithwaite, laboratory section director.

Dr. P. F. Derr becomes process research supervisor in the laboratory section of the research and development department of FMC's Westvaco Chlor-Alkali Division. Dr. Derr was with the Alabama Ordnance Works of DuPont before joining Westvaco in 1945.

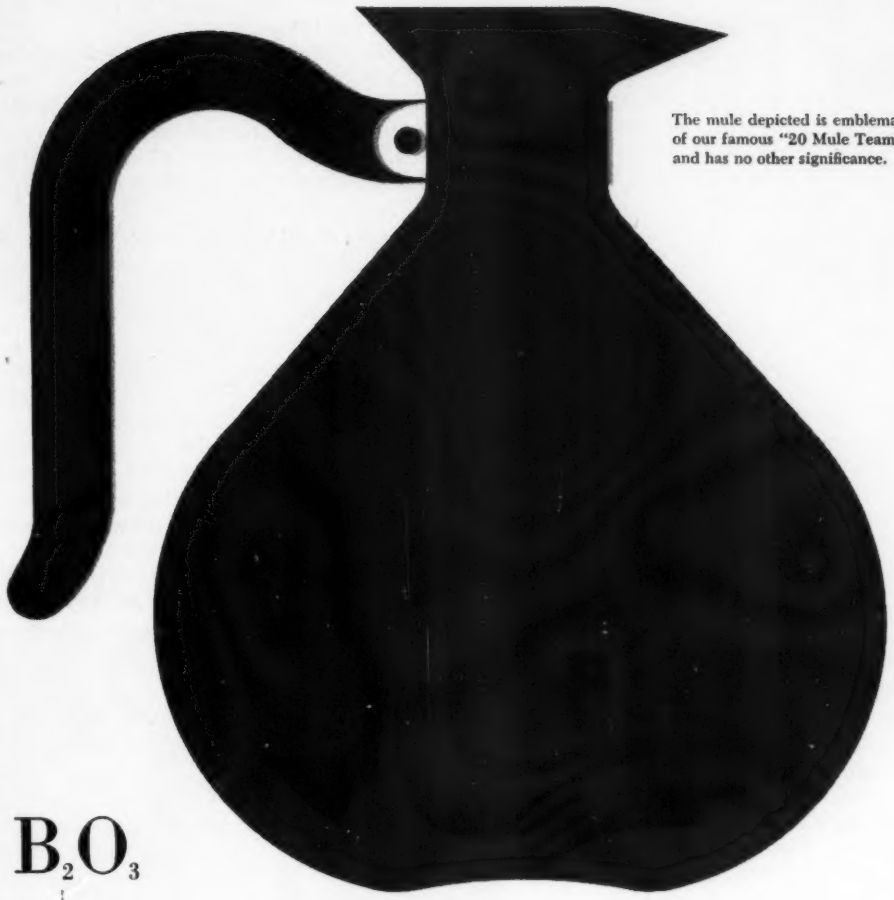
Dr. Raymond Annino is named analytical research supervisor in the laboratory section of the research and development department of FMC's Westvaco Chlor-Alkali Division.

G. S. Haines, who has been with Westvaco research since 1939, becomes technical staff assistant to the laboratory section director of the research and development department of FMC's Westvaco Chlor-Alkali Division.

BABCOCK & WILCOX AWARDED FIRST LICENSE FROM ATOMIC ENERGY COMMISSION

The Babcock & Wilcox Company has become the first firm in the United States to obtain general licenses from the Atomic Energy Commission to receive and use special nuclear and nuclear source materials, it was reported at the opening of the Atomic Industrial Forum's annual conference recently.

The licenses, each of which covers a five-year period ending in August, 1961, apply to fuel element production operations in B&W's Nuclear Facilities Plant in Lynchburg, Virginia.



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OLIN MATHIESON APPOINTS B. H. WOJCIK

All research activities in the Industrial Chemicals Division of Olin Mathieson Chemical Corporation have been combined under the direction of Dr. Bruno H. Wojcik, who has been named manager of research and development for the division, it was announced by John O. Logan, divisional vice president and general manager. Dr. Wojcik's headquarters will be located in Baltimore, Maryland.

In addition, Bernard H. Nicolaisen has been appointed assistant manager of research and development in charge of the division's laboratories at Niagara Falls, N. Y., and Dr. Chester White will supervise the Rochester, N. Y., laboratories, formerly the Genesee Research Corporation.

Dr. Wojcik came to Olin Mathieson in 1950 from the Hooker Electrochemical Company, Niagara Falls. He is known for his work in the polymerization and high pressure hydrogenation fields, and he holds a number of patents on the preparation of organic sulfides, fluorides and chlorides.

O-I AND NATIONAL CONTAINER MERGER APPROVED

Merger of Owens-Illinois Glass Co. and National Container Corp. was approved September 17 by shareholders of both companies. Owens-Illinois had its meeting in Toledo, Ohio, and National Container met in New York City.

J. P. Levis, Owens-Illinois board chairman, said that the merger is scheduled to be completed and consolidated operations begun on October 1. The business of National Container Corp. will be operated under that name as a wholly-owned subsidiary of Owens-Illinois.

SIGMA DELTA EPSILON OFFERS FELLOWSHIP

Sigma Delta Epsilon, Graduate Women's Scientific Fraternity, is offering for the year 1957-1958, a $1600 postdoctoral research fellowship to women specializing in the mathematical, physical, and biological sciences.

Applications for the year 1957-1958 should be submitted before February 1, 1957, to the Fellowship Awards Board which is authorized to make the seventh Sigma Delta Epsilon Fellowship Award.

Women with the equivalent of a Ph.D. degree, carrying on research in the mathematical, physical, or biological sciences, who need financial assistance and give evidence of high ability and promise are eligible. During the term of her appointment the appointee must devote the major part of her time to the approved research project, and not engage in other work for remuneration (unless such work shall have received the written approval of the Board before the award of the fellowship).

Application blanks may be obtained from Dr. Dorothy Quiggle, Petroleum Refining Laboratory, The Pennsylvania State University, University Park, Pennsylvania. Announcement of the award will be made early in March 1957.

H. G. LEWIS ELECTED VICE PRESIDENT

General Lucius D. Clay, chairman of the Board of Continental Can Company, Inc., announced the election of Howard G. Lewis, Wheeling, West Virginia, as a vice president of that company.

Mr. Lewis formerly was the executive vice president of Hazel-Atlas Glass Company.

The Hazel-Atlas Glass Company has been acquired by the Continental Can Company and will be operated as the Hazel-Atlas Glass Division of the Continental Can Company, Inc., under the supervision of Mr. Lewis.

PITTSBURGH PLATE APPOINTS R. P. BELL

Appointment of Richard P. Bell as assistant to the president has been announced by David G. Hill, president of the Pittsburgh Plate Glass Company.

A native of Pittsburgh, Pa., Mr. Bell is a graduate of Shadyside Academy and Princeton University. He joined Pittsburgh Plate during 1938 as a salesman at the firm's Baltimore distributing branch.

Following five year's service as an officer with the U. S. Army, Mr. Bell was appointed paint manager of the Pittsburgh, Pa., branch. During the past four years, he has served as assistant general manager of paint sales for the firm's merchandising division.

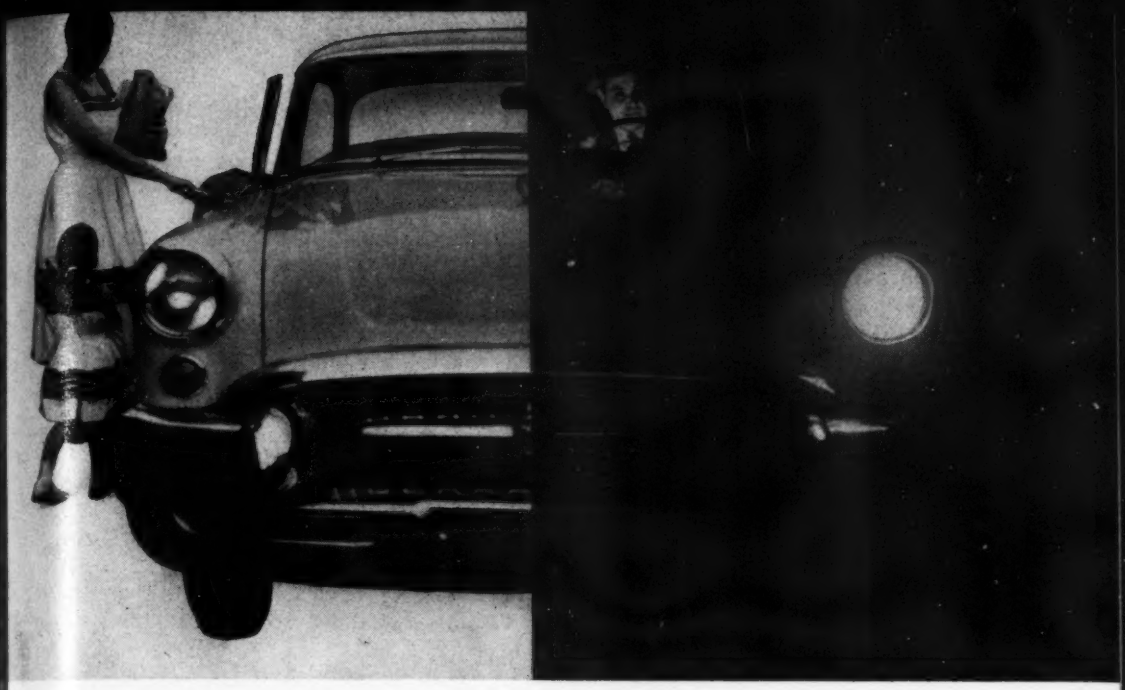
F. W. HASSETT RECEIVES MERIT AWARD

H. Dean Menoher, (left) congratulates F. W. Hassett

Frederick W. Hassett, manager of Glass Products, Inc., was presented with a certificate representing an Award for Merit issued to him by the Research Institute of America for his "Effective and unique contribution to the development of executive skills in human relations for manpower utilization." This is the second consecutive year in which Mr. Hassett has received such an award from the Institute; both times as a result of his efforts toward improving employee morale within his plant.

Glass Products, Inc. is a subsidiary of the American Window Glass Company of Pittsburgh. Mr. Hassett has been associated with this company for four years. Since being employed at Glass Products, Inc., he has consistently directed his efforts toward improving morale through an effective employee relations program.

H. Dean Menoher, vice president - manufacturing, American Window Glass Company, was present in behalf of the American Window Glass Company president, Otto G. Schwenk, to congratulate Mr. Hassett.



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Therefore, the making of refractory products is the most basically necessary industry there is. Refractories, you see, create industry . . . without them, there would be no industry.

Providing industry with Castables, Plastics, Ramming Mixes, Fire Brick, Mortars, Insulating Brick and Insulation, General Refractories Company draws resources from all over the globe—and operates the world's largest, most-modern refractories research laboratory.

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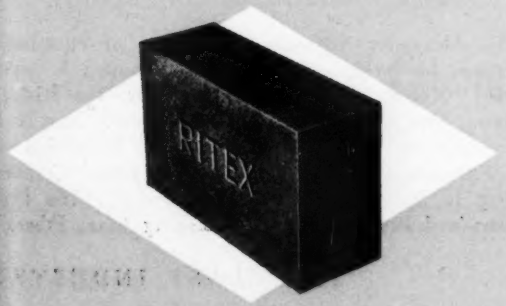
RITEX basic brick, for regenerator chambers and checkers, make a four year campaign more than a wistful dream. Unaffected by batch carry-over and condensed soda, RITEX magnesite checker brick retain their full size and original regenerator efficiency month after month. RITEX CHROME brick, for the regenerator crowns and walls, have low conductivity which can be translated into fuel savings. They can be insulated without seriously affecting their service life because they do not melt or slag at the operating temperatures encountered.



Grefco fire clay brick are recommended for the lower portions of the checker settings, the lower regenerator walls, the rider tile and for lining the flues.

Grefco silica brick, for caps and breast walls, are uniform and of highest quality, and are available in standard or super duty grade.

You will find one or more Grefco plants ready to supply each major glass producing district at minimum transportation costs.

L-O-F Record Expansion . . .

(*Continued from page* 560)

with maturities planned to meet scheduled appropriations.

From the customer standpoint the expanded capacity has given improved product, opened the door to new products, speeded up shipments, and through efficiencies has helped to resist advancing costs.

From the standpoint of employment it has been estimated that the 1955-56 expansion programs may add about 1,400 jobs in the various plants affected.

Immediate effects of expanded facilities have been to return some of the non-continuous operations to a six-day week schedule as contrasted with the emergency seven-day week in the last two years.

Inventions and Inventors . . .

(*Continued from page* 565)

Sheet and Plate Glass

Glass Grinding Machines. Patent No. 2,745,227. Filed September 10, 1953. Issued May 15, 1956. One page drawings; none reproduced. Paul J. Pilger.

This invention relates to improvements in propulsion heads for use with glass grinding machines.

The novel propulsion head assembly consists of a multiplicity of non-metallic guide plates spaced apart a distance substantially equal to the thickness of the glass plates, the edges of which are to be ground. The guide plates are all aligned with a soft metal core which ties all the plates together and are securely clamped together in order that the assembly may be propelled through the grinding machine for simultaneously grinding the longitudinal edges of the sheets. The novel head assembly is cheap and results in a considerable saving in cost.

There were five claims and the following references were cited in this patent: 1,571,985, Weber, Feb. 9, 1926; 1,906,329, Mermer, May 2, 1933; 1,955,981, Smith, Apr. 24, 1934; 2,154,749, Hines, Apr. 18, 1939; 2,160,085, Robertson, May 30, 1939, and 2,531,640, Oberstar, Nov. 28, 1950.

Sealing Iron Cone To Glass Window. Fig. 3. Patent No. 2,722,085. Filed November 6, 1951. Issued November 1, 1955. One sheet of drawings. Assigned to Hartford National Bank and Trust Company by Johannes de Gier and Theodorus Hagenberg.

This invention relates to a method of sealing an iron cone to a glass window of a cathode-ray tube.

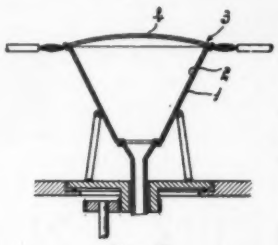


Fig. 3

An ingot iron cone 1, the wide end of which is 40 cms. of diameter, is coated with a nickel layer 2, of less than 20μ for example, 10μ. Then the sealing zone 3 at the wide end is heated for three minutes in an oxidizing flame at 950 to 1000°C. Thus, the sealing zone 3 is degasified, while approximately 8 microns of the nickel-layer 2 is converted into oxide and degasified, together with the iron substratum. The glass window 4, which may be preheated, if necessary, is immediately brought into contact with the heated end 3 of the cone 1, after the latter has been cooled down, if required, to a temperature which is not harmful to the window. The temperature of the glass is then raised, the edges 3 of the cone and the window are sealed, for example at 900 to 950°C. and then cooled in the conventional manner to relieve strain in the glass. The nickel layer inside the cone is found to resist the chemical and mechanical cleaning means, which are used for cleaning the cone and for the application of the fluorescent screen. It also protects the iron wall from the settling liquid. If necessary, the nickel-plated sealing zone may be previously locally coated with a chromium layer of less than 20μ, preferably 3μ, which is converted wholly or in part to chromium oxide during the degasifying operation.

There were four claims and the following references were cited in this patent: 789,515, Whitney, May 9, 1905; 1,844,936, Hotchkiss, Feb. 16, 1932; 2,240,063, Allen, Apr. 29, 1941; 2,480,453, Dorgelo et al., Aug. 30, 1949; 2,482,494, Knochel et al., Sept. 20, 1949; 2,555,877, Doran, June 5, 1951; 259,927, Great Britain, 1926, and 585,921, Great Britain, Feb. 28, 1947.

• Dr. Alexander Silverman, Professor of chemistry, Emeritus, University of Pittsburgh presented a paper entitled "Modern Glass at Alfred" before the History Division, American Chemical Society, Atlantic City, N. J. last September 18th. October 9, 1956 he addressed the Pittsburgh Section of the American Ceramic Society in Mellon Institute auditorium on "The Production and Properties of High-melting Glass Fibers".

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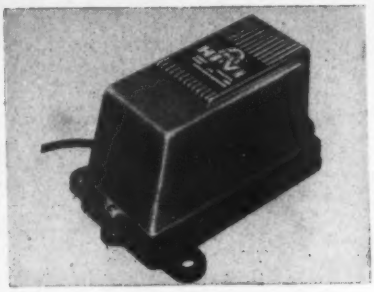

Pat. Pending

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HI-VI units are lightweight, compact, sturdily constructed, have no friction-producing parts to wear. Low operating costs, little maintenance. Lifetime Alnico V magnetic element is the heart of the unit.

ERIEZ HI-VI VIBRATORY EQUIPMENT Pat. Pending

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SOLVAY ANNOUNCES NEW PRICES

Solvay Process Division, Allied Chemical & Dye Corporation has announced revised price schedules on light, intermediate and dense Soda Ash, to become effective October 1, 1956.

The new schedules f. o. b. maker's works are as follows:—

		Bulk Per 100 Pounds	Bags Pounds
58% Light Soda Ash	carloads	$1.55	$1.85
58% Intermediate Soda Ash	carloads	1.55	1.85
58% Dense Soda Ash	carloads	1.60	1.90

WALBRIDGE MEMORIAL BOOK FUND ESTABLISHED AT UNIVERSITY OF TOLEDO

Contributions to the E. Cornell Walbridge Memorial Book Fund at the University of Toledo have reached $2,685, it was announced by President Asa S. Knowles.

The fund was started on July 23 upon the death of Mr. Walbridge, a member of a pioneer Toledo family and general manager of distributor sales for the Libbey-Owens-Ford Glass Company. The idea was approved by members of his family and associates.

President Knowles said gifts have continued to come in within the last month from business firms and individuals in many parts of the nation, many in amounts of $50 to $100.

Specific plans for the use of the memorial book fund have not been developed but it is believed one of the first steps will be to acquire for the University Library many books dealing with the glass industry and glass problems.

In his service with Libbey-Owens-Ford since 1924, Mr. Walbridge had contacts with glass distributors and dealers all over the country and in his recent position was in close touch with the six regional and 24 district sales offices of the company.

CORNING GLASS APPOINTS R. C. ELLETT

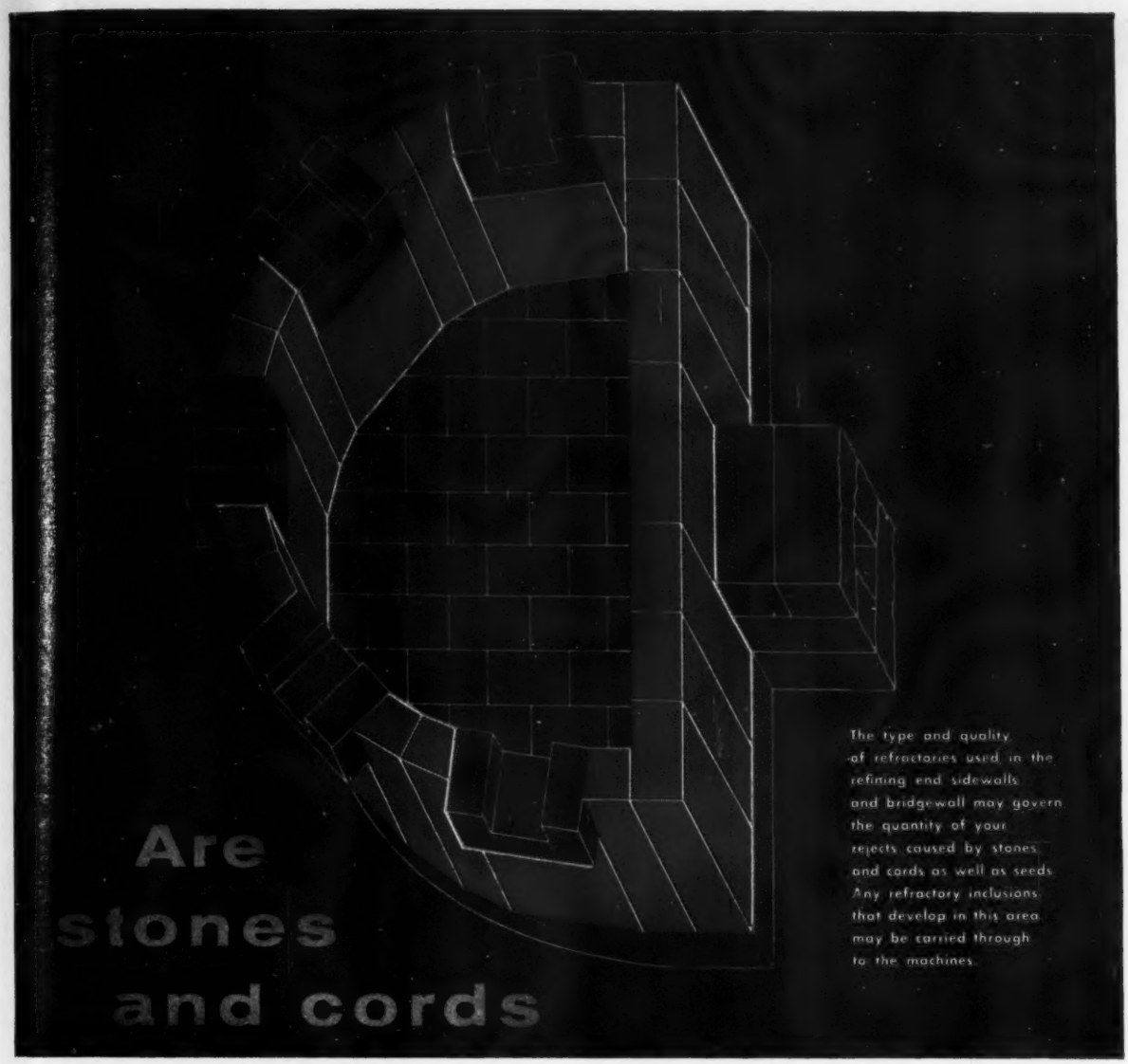
Appointment of Robert C. Ellett as chief engineer for plants and buildings at Corning Glass Works was announced recently by Arthur W. Weber, director of engineering. In the newly created position, he will coordinate and direct the company's engineering program for plants, facilities and structures.

Mr. Ellett joined the mechanical development department in 1950 and after a year as supervisor of machine design was appointed manager of quality and process engineering in the Electrical Products Division. He was named manager of Pilot Plant 2 in 1953.

WILLIAM J. GREEN NAMED GCMI TRUSTEE

William J. Green, executive vice president of the Thatcher Glass Manufacturing Company, Inc., of Elmira, New York, has just been elected to the board of trustees of the Glass Container Manufacturers Institute, Inc.

Franklin B. Pollock, Thatcher's board chairman and president, resigned from the GCMI board after five years of service. Mr. Green fills Mr. Pollock's unexpired term.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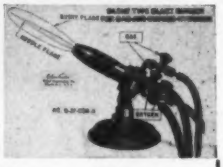

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AMERICAN NEPHELINE MOVES SALES HEADQUARTERS TO TORONTO

Mr. H. R. Deeth, vice president & sales manager, American Nepheline Ltd., recently announced the opening, effective August 1, of new sales offices for Lakefield Nepheline Syenite, Canadian Bank of Commerce Building, Room 2530, 25 King Street W., Toronto, where Mr. Deeth will be located. The sales offices at Lakefield will be closed with this move.

With the completion of the new $2,500,000 mill at Nephton, Ontario, the operations formerly carried on at Lakefield by American Nepheline Ltd. are being consolidated in the new plant. All shipping will now be done from Nephton. Officers of American Nepheline Ltd., a subsidiary of Ventures, Ltd., are: Mr. A. L. A. Richardson, president; Mr. E. Craig, vice president & general manager; Mr. H. R. Deeth, vice president & sales manager; Mr. D. D. Anderson, secretary-treasurer.

Sales in the U. S. A. are handled through C. L. Cruikshank, manager, Ceramic Division of Great Lakes Foundry Sand Co., United Artists Bldg., Detroit, Mich. Ceramic research is in charge of Dr. C. J. Koenig at the Engineering Experiment Station, Ohio State University, Columbus, Ohio. Dr. Koenig is director of research for American Nepheline Ltd.

SOCIETY OF RHEOLOGY 1956 ANNUAL MEETING

The Society of Rheology will hold its 1956 Annual Meeting in Pittsburgh, Pennsylvania, on November 7-9, 1956. The technical sessions will be held at the Mellon Institute and the meeting hotel will be the Webster Hall.

Among the papers scheduled for presentation are ones covering such topics as adhesion, the effect of hydrogen on metals and metal alloys, methods for the experimental determination and theoretical evaluation of viscosity data, and the mechanical rupture of polymeric materials.

An important feature of the meeting will be the award of the Society's Bingham Medal. This will occur on Thursday evening, November 8th, in connection with the Social Hour planned for the meeting.

H. K. PORTER ACQUIRES PROPERTY

The Blackmer and Post Property, 2801 Hereford Avenue, St. Louis, Mo., was acquired by H. K. Porter Company, Inc., according to a recent announcement by T. M. Evans, Porter's president.

The 20-acre industrial site is a few blocks southwest of the geographical center of the city. The acquisition signals Porter's interest in the Vitrified Clay Products Field. It is anticipated that manufacturing facilities and methods at this plant will be improved.

For the last five years the property has been leased and the plant operated by the Laclede-Christy Company Division of H. K. Porter Company, Inc.

Mr. Evans stated that the plant staff, about 80 employees, will continue with the new Porter unit. He said that the acquisition will make possible the development of plant facilities and improvement of product quality which will strengthen the plant's competitive position.

• C. R. Fay, vice president and controller, Pittsburgh Plate Glass Company, Pittsburgh, has been reelected a trustee of Controllership Foundation, Inc., research arm of the Controllers Institute of America.

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